EDITORIAL

IN the article describing the system of the West Side irrigation district, appearing in our March issue, the statement was made that the Austin trenching-machine dug an average of 100 linear feet of trench per day. This should have been 225 feet.

WHEAT is the crying need of our Allies at the present time. The Food Administration has reduced the wheat in the 'honor ration,' which was printed in our last issue, from three pounds to a pound and a half per person per week. To follow this rule is a very little thing, and should not even cause inconvenience, yet it may help save the lives of our Allies.

THE Ordnance Department needs a larger number of civilian workers having at least a high-school education and some shop experience for inspectors, metallurgical chemists, engineers of tests, and machinists. Applications will be received at any time. Further information may be obtained from C. V. Meserole, Room 800, 79 Wall street, New York.

THE method of wood preservation described on page 77 of our February issue as having been newly developed in Hungary is practically the same as that invented several years ago by O. P. M. Goss, consulting engineer for the West Coast Lumbermen's Association of Seattle and Portland. This method is described on pages 50 to 57 of the 'Structural Timber Hand Book on Pacific Coast Woods,' compiled for the Association by Mr. Goss.

WAR-SAVINGS stamps and thrift stamps sold up to February 28 amounted to nearly $100,000,000, $47,000,000 worth being sold in February. The average amount per capita for the entire country is $0.89. The Western States have all exceeded this amount or else come close to it, the record being as follows: Oregon, $1.24; Montana, $1.19; Washington, $1.15; Nevada, $1.15; California, $1.02; Arizona, $0.99; Utah, $0.87; Idaho, $0.80. However, there is no reason why these figures should be so much smaller than the record of Nebraska of $4.39. See if you can manage to help your State's average.

THE Third Liberty Loan will be for $3,000,000,000 and any over-subscriptions, and the rate of interest will be 4¼%. Bonds of the first and second issues are convertible to bonds at this new rate, but bonds of the third issue will not be convertible to bonds of any later issues. The total amount is not so large as had been expected, since this business of war has not thus far proved as expensive as the authorities at Washington had feared. The amount should and will be over-subscribed. If there had been any need of proof that everyone should subscribe to the full extent of his ability, the events of the past few days on the western front have supplied it.

AN aerial mail-service between Washington and New York by way of Philadelphia will be started not later than April 15. Bids for furnishing aeroplanes for this work were rejected and arrangements have been made for the War Department to furnish the Post-Office Department with six Army machines. Trips will be made daily except Sunday on a fixed schedule. Not to exceed 300 pounds of first-class matter occupying a space not exceeding 25 cubic feet will be carried each trip. The estimated time for the trip from New York to Washington, including the stop at Philadelphia, is three hours, or about half the express-train time between the two points.

ONE year ago on the sixth of the month America entered the War. It is probable that the series of battles known as the German offensive will not have been definitely decided by the time the full year has elapsed. The statement is frequently made that the battles now in progress on the western front will change the entire course of the world's history. In a certain sense this is true. In another sense it is not. At this writing, it is barely possible that the German army may be able to break through the Allied line. But it is impossible that German autocracy should ultimately triumph. "Nothing is ever settled that is not settled right," and the War must go on until the entire autocratic system has been crushed, never to recover.

Concrete Ships

In another column appears a description of the 5000-ton concrete ship 'Faith,' designed by Mr. Victor H. Poss of San Francisco, and recently launched at Redwood City, California, together with a discussion of concrete ships in general. Other concrete vessels are now under construction in various parts of the United States and practical demonstrations of the sea-going qualities of large-sized concrete ships will soon be made. So far little has been shown except that large hulls can be constructed of concrete that will float in still water without appreciable leakage. Only the test of sea-going service can demonstrate the availability of concrete for large self-propelled vessels. On the other hand, the indications have all been favorable up to the present time.

It is, of course, true that concrete ships will have to be built both cheaper and faster than the 'Faith,' if they are

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to compete with the steel ships. While the peculiar reticence shown by the owners regarding all details of construction makes it impossible to determine the exact amount of concrete used, computations show that it could hardly have exceeded 2000 cubic yards and was probably nearer 1600. Using the larger quantity, assuming that the statement of the owners that 550 tons of steel was used, is correct, and also assuming the very high costs of $40 per cubic yard for concrete in place and $0.15 per pound for steel in place, the total cost for these main items is $245,000. The cost assumed for concrete is certainly sufficient to cover the cost of the form-lumber, and $25,000 is a liberal estimate for incidentals, including timber used in flooring, etc., giving a total of $270,000 for the hull, against the $450,000 estimate made by the builders. It must be remembered, however, that this ship was an experiment and work must necessarily have been slow and expensive. This is indicated by the fact that it appears to have taken about 100 working-days to pour the relatively small amount of concrete required. Other ships of either this or a similar design can undoubtedly be constructed with greater speed and less cost.

The Calaveras Dam

On March 24 at about eight o'clock in the morning, the up-stream toe of the Calaveras dam of the Spring Valley Water Company slid into the water, the reservoir releasing the clay and mud in the central pond between the two toes and completely wrecking the concrete gate-tower. The wreckage blocked the outlet-tunnel, so that no water escaped down the canyon below the dam. About five minutes elapsed between the first signs of failure and the final collapse. Fortunately no one was at work on that part of the dam, so no lives were lost.

The dam is situated about 50 miles south-east of San Francisco and was being built by the Spring Valley Water Company. When completed it would have provided a storage capacity of 53,000,000,000 gallons. It was being constructed by the hydraulic-fill method, the material for the toes being excavated with a steam-shovel and deposited partly by wagons and partly by cars. The total height of the dam was to have been 240 feet. At the time of the failure both toes had been carried to a height of about 200 feet. The outlet-tunnel and gate-tower, both of concrete, had been completed. The estimated cost of the dam was $2,500,000. The failure of the up-stream toe will probably increase the cost between $500,000 and $750,000, and will delay for one year the completion of the dam, which was to have taken place during the present year.

When completed, as it undoubtedly will be, the Calaveras dam will be the highest earth dam in the world. Since engineering is not an exact science, the building of any structure for which there is no precedent must necessarily be attended by some uncertainty. In recent years, we have seen two failures on the Quebec bridge, and the third attempt successful. Progress, however, is impossible unless precedent is sometimes disregarded. In the case of the Calaveras dam, every effort was made by the company to ensure success and safety. The project has been under consideration for many years and the best hydraulic engineers and geologists have examined the site. While there has been some disagreement as to the best site, all the consultants have agreed that the one chosen was suitable. Work was commenced in 1913. Part of the material in the toes has been placed by contract and the remainder of the work has been done by day-labor, all under the careful supervision of the company's engineers, and every engineer knows that Spring Valley Water Company structures are always models of good workmanship. Yet the dam, in part, has failed.

There has not been time to make the careful investigation of all conditions that is necessary before a definite opinion can be expressed as to the cause of the failure. At first sight, the disaster might seem to indicate that the hydraulic-fill method is not suitable for the construction of very high dams. This, however, is not probable. The San Fernando dam on the Los Angeles aqueduct is 145 feet high, and no difficulties were experienced during its construction. It is more probable that the failure may be traced to the character of the material used in the hydraulic fill. Many of the clays in the Coast range contain a large proportion of collodial matter, which remains in suspension for a long time. Probably the semi-fluid mass of mud and clay in the central pond exerted a lateral pressure against the up-stream toe considerably greater than would have been produced had the material been less colloidal.

While the loss in money is to be deplored, the delay in the completion of the dam is relatively unimportant. Pipe for the line to carry the water from the reservoir to San Francisco has not even been ordered, and there is little hope that a priority order could be obtained for it. The only way that the water could be made available would be by turning it loose down Alameda creek and picking it up at Sunol. However, the Niles filter-beds and the Pleasanton wells together are normally able to keep the Sunol pipe-line supplied to capacity, so that little or no increase in the supply available for San Francisco would be possible.

The failure calls attention to a much-disputed point in public-utility regulation and finance, namely, the provision of a contingent fund. The company has not been allowed to provide such a fund. Now it is faced with the need for the expenditure of several hundred thousand dollars. How is it going to obtain this money? It will not be allowed to get it from increased rates. The State Railroad Commission would probably refuse an application to issue either stocks or bonds for this amount, even if such securities could be marketed successfully at the present time. The money must come from a reduction in dividends, either directly, or else indirectly by the issuance of short-term notes, which must eventually be paid from the funds that would otherwise be available for dividends. Either way, the stockholders suffer, as they would not have done had the company been allowed to provide a contingent fund.

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REVIEW OF THE MONTH

SIX-CENT street-car fares in Portland, as established by the Public Service Commission, have been upheld by the Circuit Court of Multnomah county. The decision of the Court does not consider the expediency of the increased fare, merely the question of the right of the Public Service Commission to regulate rates of public utility companies within the State. The contention of the city of Portland that under the Oregon system such power is delegated to chartered municipalities was denied. A legislative enactment fixing street-railway fares at five cents in cities of 50,000 or more was also held to have been superseded by the act creating the Public Service Commission.

WAGES of railroad trainmen and other employees are being investigated and will probably be increased. We believe that the compensation of an engineering employee is usually called a salary. The principal difference between salaries and wages at the present time is that the latter are larger, having been raised several times in the past few years, while the salaries of the technical staff have remained practically stationary. Besides the injustice of this state of affairs, the railroads must suffer in the end because many of their best men will take other and more remunerative positions. The compensation of the men on the technical staffs of the railroads should be increased, and this increase should be greater in proportion than the increase granted to other employees.

ELIMINATION of new construction not directly connected with war needs was again shown to be the policy of the California State Railroad Commission when it denied the petition of the Pacific Electric Company to build electric lines from Anaheim to Irvine and from Glendora to Gold Hill, about 15 miles in all, altogether a considerable amount has already been spent on engineering and the purchase of right-of-way and materials. It was further shown that these lines are in territory that is also served by the Atchison, Topeka & Santa Fe Railroad. Building the lines would not only be in opposition to the policy of co-ordination desired under Federal control, but also, the Santa Fe company being under Government control while the Pacific Electric company is not, would give the latter road an unfair advantage, particularly if the railroads are returned to private ownership after the War.

'DAYLIGHT-SAVING' is now the law of the land. We regret that the date of going to press prevented our obtaining data regarding the number of people who were late to church on Easter morning. It is also singularly appropriate that the law that will assist an entire nation in fooling itself should go into effect on the first of April. However, the best indication of the beneficial effects of daylight-saving is the fact that the various countries and districts that have tried it are satisfied. The principal engineering aspect of the question is the effect on the consumption of gas and electricity for lighting. There will undoubtedly be some saving in both. What is perhaps more important than the actual saving in quantity is the advance in the time of the afternoon peak-load on street-car systems. This may move the street-car peak in many towns far enough away from the lighting-peak to reduce the maximum peak-load on the entire electric system.

COST-PLUS-PERCENTAGE contracts on the Army cantonments have been criticized unfavorably, frequently by people that should have known better. A statement recently issued by Major W. A. Starrett, chief of the Emergency Construction Division of the War Industries Board, is of interest, particularly with respect to the claim that extravagant profits were made. On contracts under $100,000 a 7% profit was allowed, this proportion being reduced to as little as 2½% on the larger work, with the further limit of $250,000 profit on any one contract. From the nominal profit should be subtracted the contractor's overhead, sometimes as much as $100,000. Since income, excess-profits, and other taxes must be deducted from the remainder, it seems probable that no contractor received more than a modest compensation for the time and energy expended. No one denies that, given ample time, the cantonment structures could have been constructed at a considerably lower cost by resorting to competitive bidding or some other method. However, the country's need for those structures was urgent, and the most feasible method for building them in the shortest possible time was adopted.

PREPARATION of land for irrigation is one of the most important problems of the new settler in arid or semi-arid regions. While some land is so smooth that the cost of this work is almost negligible, other land, perhaps in the same vicinity and equally fertile, may be so broken that the cost of preparation is practically prohibitive. Furthermore, as is shown in Mr. Cronholm's article in this issue, the preliminary part of the work is something that can be done better on a large scale than by the individual farmer, who will have plenty to occupy his time without this additional burden. While the plan of doing this preliminary leveling before the individual farmer goes on the land originated with the United States Reclamation Service, we believe that other

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projects, both public and private, will do well to follow its example. Where there is no certainty when or by whom the particular farm-unit is to be occupied, it will probably be best to confine the preparatory work to the 'rough-leveling' described in Mr. Cronholm's article. On the other hand, on such projects as the new colony to be established in Butte county, California, by the State Colonization Board, where every farm will be occupied in a short time, considerably more preparatory work can be done. Not the least important aspect of such work is the fact that under the old conditions many farmers prepared their land inadequately and trusted to luck to distribute the water evenly over their fields. With the preliminary work done, not only will more acres be placed under cultivation but the yeld per acre will be increased.

POWER conditions in that part of California south of Merced were discussed in a statement recently by the State Railroad Commission. The principal companies serving this territory are the San Joaquin Light & Power Corporation, the Mount Whitney Power & Electric Company, the Southern California Edison Company, the Southern Sierras Power Company, the San Diego Consolidated Gas & Electric Company, and the Los Angeles Gas & Electric Corporation. These companies produced 1,146,000,000 kilowatt-hours in 1917, of which 911,000,000 kilowatt-hours was produced by hydro-electric plants and the remainder by steam-electric plants, the latter consuming oil and natural gas equivalent to 1,316,000 barrels of fuel-oil. The demand for power will probably increase at a rate of 140,000,000 kilowatt-hours per year. Unless the consumption of oil is to be increased, a thing that should be prevented if possible in view of the decreasing available supply, the capacity of the hydro-electric plants should be increased at the rate of 25,000 kilowatts per year. An investigation was made of existing and proposed developments by the city of Los Angeles along the line of the aqueduct. The expenditure of between $2,500,000 and $3,000,000 would give an additional peak-load capacity of 36,000 kilowatt and an increase of output of 115,000,000 kilowatt-hours per year. Provided priority orders were obtained for equipment, this additional development could be practically completed in one year, but there is little hope that the work will be done. The city contends that the bonds already authorized must be used for construction of distribution systems. The suggestion is made that if the Los Angeles Gas & Electric Corporation will lease its distribution system to the city, the bond-money can then be used for hydro-electric development. This the corporation refuses to do. The Railroad Commission has no power to force a solution of this muddle, which is one of the worst cases of an alliance of red tape and obstinacy to help the Kaiser that has come to our attention. The Railroad Commission does recommend, however, that $20,000,000 be spent on hydro-electric development in the territory under consideration, $15,000,000 of which would be by the Southern California Edison Company.

COMPETITION between public utilities has no friends and few apologists in these days. We can safely say that it will never be encouraged again. When, however, two or more corporations survive in a given field from the old days of unregulated competition, the question of proper valuations and rates is intricate. In practically every case there is some duplication of facilities by the different companies that would not have occurred had one company occupied the field since the beginning. Under such conditions, what is the amount of the investment upon which a return should be allowed? In the article appearing in another column on the trans-bay rates at San Francisco, one answer to this question is presented, namely, that the competing companies are not entitled to any greater return than what would be a reasonable return on the investment required for a single system capable of giving equally good service. The other extreme is represented by the demand for return on the total investment. In such a case, justice to all concerned probably lies somewhere between these two views. So far as we know, the California Commission has not thus far had occasion to rule on a similar case. The entire question is complicated further by the fact that there was an intimate and presumably entirely legitimate connection between the construction of a large part of the suburban facilities and the operations of real-estate companies handling property in the territory served by these facilities. The value of this property was enhanced by the construction of these transportation facilities, and this furnishes grounds for the claim that some of the cost of construction of these facilities should be 'written off' because of the increased property-values. Several cases have come before the Commission where a real-estate company, in order to help the sale of its property, has constructed a water system to serve the property, usually under an agreement to supply water at relatively low rates. After a considerable number of the lots have been sold, a water company is generally formed to take over the water-selling activities of the parent company, and an application is made to the Commission for an order fixing rates. Under these conditions the Commission has seldom allowed rates high enough to yield a reasonable return upon a fair valuation of the water system, considered as a separate concern, holding that the real-estate promoters should and probably did look for part of their return in the increased value of lots. It is quite likely that the members of the Commission will take a similar view in the trans-bay rate cases, although this would not necessarily prevent them from granting some increase in rates.

LOANS to farmers from the various Federal Land Banks amounted to $50,000,000 on February 1, of which $12,000,000 was loaned during January. The total number of loans was 24,000. Over 100,000 applications, amounting in all to $260,000,000, are now on file. The leading banks in order of the amount loaned are as follows: St. Paul, $9,760,400; Spokane, $8,930,075; Wichita, $8,643,200; Berkeley, $3,666,600; Omaha, $3,210,190; Houston, $3,121,412.

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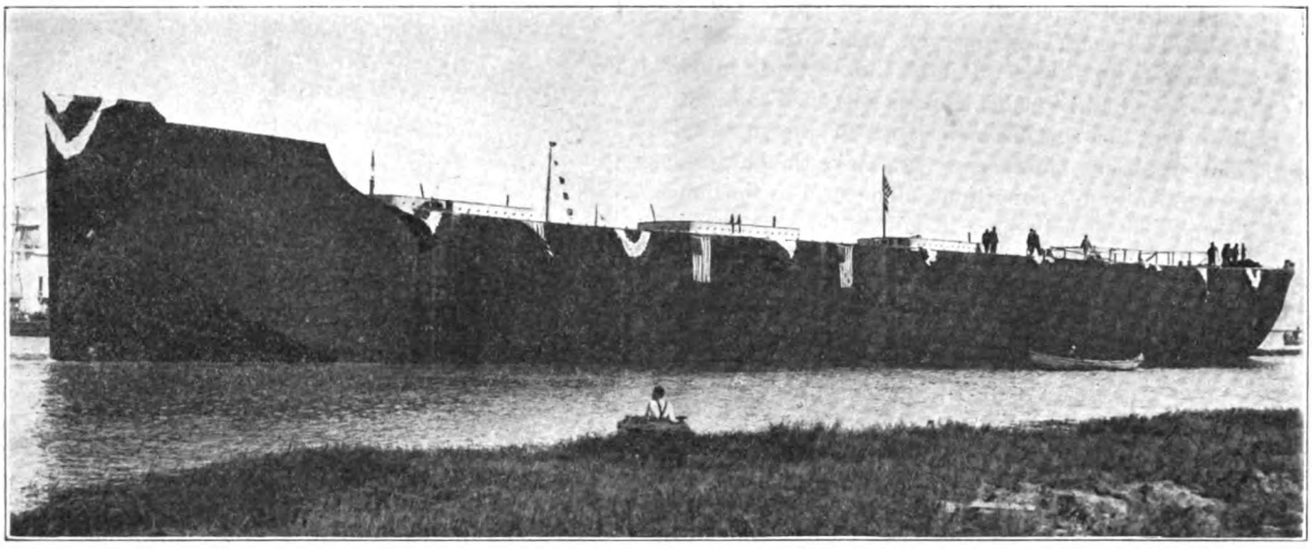

THE 5000-TON CONCRETE SHIP 'FAITH'

The Design of Concrete Ships*

By L. R. FERGUSON †

In designing a ship, it is assumed to be supported in two ways, first, for 'hogging,' and second, for 'sagging.' That is, the wave in one instance is supposed to support the ship in the centre, with the ends unsupported. In the second case, the ship is supposed to be supported at the bow and stern on the crest of the waves, the trough of the wave being under the centre of the boat. These waves are supposed to have a height equal to 1/20 of the length of the ship. Considering the ship as a beam, this produces alternate tensile and compressive stresses in both the top and the bottom of the structure. This governs the design of the ship as a longitudinal girder.

The ship must also be designed so that the sides and bottom will resist hydrostatic pressure. For this a system of transverse members called frames is provided. The accepted method of designing the frame is to consider the frame as a ring and to use the ring formula. This corresponds to the elastic-arch theory. Even with the supports fixed, the design of an elastic arch is not simple. With the concrete ship nothing is fixed. We must go through a long process to determine the position of the neutral axis in different parts of the frame, under the various conditions of external force that must be considered.

Around the frame is the shell. This has two functions to perform besides the primary one of keeping out the water. First the side may be considered as a sort of floor-slab, the load being the hydrostatic pressure that is distributed to the frames or transverse members of the ship. This is a comparatively simple matter, for the frames can be spaced to obtain the desired span. In addition to this, however, the shell acts in the same way as the web of a box-plate girder. The analogy can be carried further, the boat-frames can be considered as the stiffeners, and the deck and bottom of the boat as the flanges. The most important factor in designing the shell is the shear at the quarter-points. In this connection some interesting problems must be considered. For instance, do the frames increase the shear-section, and if so, to what extent? Does the bending of the vertical reinforcement of the shell into the bottom and deck anchor these rods sufficiently to produce the same effect as rigid attachment to the longitudinal reinforcement? Probably the most important question is the effect of alternate tensile and compressive stresses in the longitudinal members.

Let us now consider some of the advantages of the concrete ship. Such consideration must be governed by present conditions, although some of these conditions will continue after we have won the War.

The material to be used in building concrete ships is plentiful and widely distributed. It is not used for ships now being constructed, so there will be no interference with present programs. The class of labor to be used for the concrete ship is different from that used on either the wooden or the steel ship, and is mostly unskilled. Above all, the speed with which concrete ships can be built is of the utmost importance.

The maintenance cost of a concrete ship will be small, although the idea, held by many engineers, that barnacles will not adhere to concrete is erroneous. This, however, can probably be overcome, and, at any rate, conditions will not be worse than for a steel ship.

*Extract from paper read at a meeting of the Delaware River branch of the American Society of Marine Draftsmen.

†Engineer, Portland Cement Association.

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The original cost of a concrete ship will probably be considerably less than steel or even wood. The resistance of concrete to fire is an important consideration. The shape of steel and wooden ships is governed to a considerable extent by the characteristics of the material used. With concrete, however, we can make the bow and stern to conform to any conditions. The steel in the concrete ship can be placed where it will do the most good, whereas in both the steel and the wooden ship the efficiency of the material is often reduced considerably by the necessity of making joints.

One of the objections frequently raised against concrete for ship construction is that the weight of the material is too great. As a matter of fact, the weight of the hull of a concrete ship will be little, if any, more than that of a wooden ship of equal carrying capacity. The disintegrating effects of salt water on concrete is another objection. This, however, can be prevented by proper methods of protection. The possibility of corroding the reinforcing-steel is more serious. The investigations of marine structures conducted by R. J. Wig and myself showed the danger of cracking where reinforced concrete is exposed to moist sea-air, provided ordinary construction methods are followed. This too can be overcome by observing proper precautions.

THE FIRST LARGE CONCRETE VESSEL*

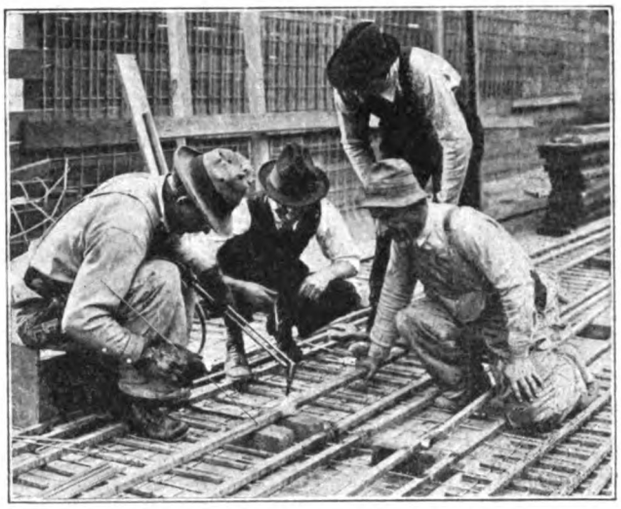
On March 14 the 5000-ton reinforced concrete ship 'Faith', built by the San Francisco Shipbuilding Co., was successfully launched at Redwood City, California. While a number of barges and a few small self-propelled vessels have been constructed of concrete this is the first large ship to be built of this material.

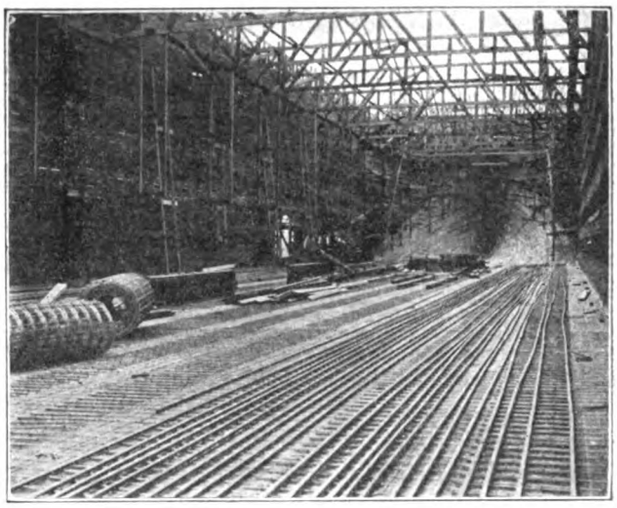
The vessel is 336 ft. 3 in. over all, the length between perpendiculars being 320 ft. The beam is 44 ft. 6 in. and the molded depth is 31 ft. The draft is 24 ft. With this draft the carrying capacity will be 5000 tons. The empty hull draws 9 ft. of water. The concrete in the hull is from 4 to 5 in. thick. There are five concrete bulkheads. The bow is reinforced with a $\frac{3}{8}$-in. steel plate. The reinforcing-steel used in the hull weighs 550 tons. The main deck is of wood resting on concrete stringers. There are three cargo-hatches. About 2,000,000 ft. B.M. of lumber was used for the forms, of which about 10% can be used again, assuming a similar design.

Work was commenced September 1, 1917, and the first concrete was poured October 31. The last concrete was poured February 26, 1918. A water-proofing compound was used in mixing the concrete. The concrete was kept wet for three weeks after pouring, but it is evident that this rule was not strictly observed, since the vessel was launched 16 days after the last concrete was poured. A heavy black asphaltic paint was used on the outside of the hull.

The estimated cost of the empty hull is $450,000 and of the completed vessel, $890,000. The vessel will be equipped with reciprocating engines developing 1760 horse-power. It is expected that the speed will be ten knots per hour. The vessel will be equipped and ready for service about June 1.

*Based mainly on data furnished by A. Macdonald, Rialto Bdg., San Francisco.





WELDING REINFORCING-BARS AND VIEW OF INTERIOR OF VESSEL

DRAWBAR-PULL REQUIRED FOR FARM-TRACTORS

In an address given at a war conference at the University of Illinois, E. A. White presented some data regarding the drawbar-pull required for farm-tractors. Tests conducted at the experiment station of the University of Illinois by R. F. Crane and C. A. Ocock indicated that under favorable conditions brown silt-loam stubble required a drawbar-pull of about 4 lb. per square inch of furrow cross-section. A 14-in. plow working at a depth of 6 in. would require a pull of 336 lb. When the soil becomes dry it is harder to plow. Tests reported by the Hyatt Roller Bearing Co. show that the draft is frequently as great as 7 or 8 lb. per square inch of furrow cross-section. Other tests have shown pulls as great as 20 lb. on dry gumbo soil.

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Valuation of Competitive Transportation Systems in the Vicinity of San Francisco*

Few rate-cases that have come before a public utility commission have excited such general interest as the applications made by the Southern Pacific Co. and the San Francisco-Oakland Terminal Railways to raise their commutation and other rates between San Francisco and trans-bay points. About 50,000 'commuters' will be directly affected, while practically the entire population of San Francisco and of the East Bay cities will be affected in one way or another. The present rate between San Francisco and most points in the East Bay cities that are reached by the lines of either company is $0.10 for a single trip, with a monthly commutation-rate of $3 entitling the holder to one round-trip per day. These rates the companies declare are unremunerative and they have asked the State Railroad Commission for an increase. A discussion of an earlier application for an increase of rates, made by the Southern Pacific Co. alone, appeared in WESTERN ENGINEERING for May 1915.

The various East Bay cities, together with a number of the commercial bodies, have joined in opposing any increase in rates. While not affirming that the present rates yield a reasonable return on the total investment made by the companies, the protestants base their main argument against an increase of rates on the claim that the companies are not entitled to a return on the cost of construction of competing lines where there is unnecessary duplication and a considerably greater investment than is actually required to give service. In support of this contention, plans for a hypothetical system under one management that would serve the traveling public as well as the two present systems has been prepared. It is not contended that this system should be built at the present time, or that the two companies should necessarily combine their systems so as to approximate the hypothetical system, but it is contended that the companies are not entitled to any return over and above a reasonable return upon the cost of construction and operation of the hypothetical system. From the evidence presented in connection with this hypothetical system, most of the data in this article are taken.

Three systems of electrically operated railroads, the Southern Pacific Co. Oakland Pier system, the Southern Pacific Co. Alameda system, and the San Francisco-Oakland Terminal Railways or Key Route system, serve the East Bay cities at present. Each system operates a ferry-line. Seven boats are operated in continuous all-day service, one extra boat is in service for one hour in the evening, and four other boats are held in reserve to insure continuity of service. In addition three boats are operated on the Oakland Harbor route, and one boat to meet Western Pacific trains. The three moles and the connecting railroad lines were built by competing companies. Many of the railroad lines serve in parallel the same territory, and there is considerable other duplication. Had this territory been served by a single company, a large part of the present facilities would never have been built.

During 16 of the 20 hours of the operating day, the traffic on the seven boats of the three lines is less than one-third of the capacity of the boats of any single line. During the rush hours of the morning and evening the traffic is such that a single ferry-line operating six boats at regular intervals somewhat shorter than those now prevailing would be sufficient to handle the traffic. The greater frequency of boats and trains would add to the convenience of the traveling public, and a single line of boats would reduce the danger of collisions in fogs.

An analysis has been made to show both the necessary investment of capital and the reasonable operating expenses for a single system so designed and operated that the service to the East Bay communities will be at least the equivalent of that now rendered by the existing facilities. To this end the proposed composite system is a system composed of such existing facilities and equipment of the San Francisco-Oakland Terminal Railways and the Southern Pacific Co. as can be used effectively without duplication and economic waste. Existing facilities that are considered unnecessary and which are eliminated from consideration are as follows: Alameda mole and terminal, Key Route mole and terminal, Key Route subway and power-house, Key Route Shattuck Avenue line north of 40th street, that part of Sacramento Street line south of Southern Pacific crossing on Stanford avenue, and that part easterly from Southern Pacific crossing near Hopkins street, Key Route Albany line, all the 12th Street and 22nd Street lines, all the California Street except that part north of the Key Route crossing near Hopkins street, the Ellsworth Street line, part of the 14th and Franklin Street line as far as street-car service is concerned, that part of the Encinal Avenue line between Pacific Junction and the Alameda mole, the Southern Pacific boat-yard. To care for the entire traffic at the Oakland mole, provision has been made for extension of the terminal-tracks, addition to the train-shed, and one additional slip. The Oakland Harbor route has been eliminated from this consideration. The total trackage of the composite system would be 100 miles, approximately the same as the present Southern Pacific Electric Suburban system.

The following is a statement of income on the present

*From data taken from exhibits submitted to the California State Railroad Commission by the cities of Berkeley and Alameda, and prepared by E. N. Prouty, deputy city engineer, Berkeley, California.

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systems in 1916 and probable income on the composite system:

Source	Key Route	Southern Pacific Co.	Composite
Passenger revenue	$1,096,742.15	$1,547,071.78	$2,641,356
Credit for half-fares to employees			27,275
Station and train privileges	27,207.82	3,508.34	18,500
Parcel-room		359.99	360
Rent and miscellaneous receipts	2,538.34	2,666.03	4,500
Boat privileges		15,709.05	15,709
Dining and buffet	240,855.59	209,841.83	450,696
Total revenue	$1,367,343.90	$1,779,157.02	$3,158,396

In this estimate the passenger revenue, and the dining and buffet revenue for the composite system is taken as the sum of the receipts of the two existing systems. At present all Southern Pacific employees are given half-fare privileges and those who have been in the employ of the company a certain number of years, passes. In the absence of definite data regarding passes in use, it has been assumed that the suburban lines should be credited, and the steam lines debited with the amount of the reduction on the half-fare tickets, assuming that the passes in use will compensate for the amount that should be charged to the suburban service on account of transportation furnished to its employees. The other items are based upon what are believed to be the most reasonable assumptions.

The estimate of valuation for way and structures is as follows:

Grading terminal	$100,000
Shops, car-house, and equipment	400,000
Pier terminal-station with extension	425,000
Water and fuel stations	42,000
Wharves and slips	280,000
Elevated structures	180,000
Draw-bridge	900,000
Track (100 miles)	4,550,000
	$6,877,000
Interest during construction	209,000
Taxes during construction	15,000
General expense	60,000
Total way and structures	$7,161,000

In computing the amount for grading the terminal, it is assumed that the amount chargeable to the suburban service is the fill south of and adjacent to the steam-line tracks for a width of 100 ft. at the station and 67 ft. along the rest of the mole. The item for shops, car-house, and equipment is $10,000 more than the amount given by the Southern Pacific Co. as the valuation for those items. The item for pier-terminal in the Southern Pacific valuation has been increased by $110,000 to allow for extension and additional facilities. Similarly the Southern Pacific charge for water and fuel stations has been increased $700. An addition of $151,000 has been made to the Southern Pacific valuation for wharves and slips, to allow for the construction of a second slip and accessories. The amount for elevated structures is approximately the same as the Southern Pacific valuation for such structures adjacent to the present 16th Street station. An allowance of $900,000 is made for the share of the suburban lines in the cost of construction of the proposed draw-bridge across the Oakland estuary. In computing interest during construction it has been assumed that the average period for each line to be completed and earning revenue would be one year. The item for general expense is for administrative expense only, other so-called general expenses, such as engineering, legal, accounting, and insurance being included in each of the separate items given above. The estimate for track construction is based mainly upon the Southern Pacific valuation.

To determine the amount of rolling equipment a study was made of the traffic on each of the present lines. Where one of the present competing lines is to be abandoned in the composite system, its traffic is assumed as all going to one of the other lines, or else divided between two adjacent lines according to assumed percentages. In this way a schedule of the probable traffic and cars required for each line for each trip during the day was prepared, and the total number of cars during the peak-hours computed. Some of the results of these calculations are as follows:

Line	Passengers during year	Maximum number of passengers on any one trip in morning	Maximum number of passengers on any one trip in evening
9th Street	1,211,394	105	107
Sacramento	1,920,170	159	161
Shattuck	5,892,410	516	524
Claremont	2,666,992	234	238
Piedmont	2,497,591	219	223
18th Street	7,663,381	672	683
7th Street	7,611,250	675	686
Alameda	4,793,453	420	427
Total	34,256,641	3000	3050

This allows for a ten-minute service for one hour in the morning and one hour in the evening, and a twenty-minute service during the rest of the day and up to 11:50 p.m. On this basis it was found that 240 cars or approximately the same number that is used by the two existing systems would be required. Of this number 140 would be motor-cars, 90 would be trailers, and 10 would be street-cars. Of motor-cars 79 would be 'large' or the size of the present Southern Pacific and 61 would be 'small' like the present Key Route cars. Of the trailers 60 would be large and 30 would be small. Based on actual cost data, a valuation of $3,110,000 has been placed on this equipment. The valuation of $1,436,123 for the necessary floating equipment, is that claimed by the Southern Pacific Co. for its ferry-boats. A valuation of $2,107,583 has been placed on the necessary power-plant as submitted by the Southern Pacific Co. The necessary land for transportation purposes has been valued at $1,100,000. The total estimated investment for the composite system would therefore be $14,903,006.

In computing operating expenses, the costs for main-

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tenance of way and structures have been taken as the same per mile of line as stated by the Southern Pacific Co. except as follows: The total amount for pavement is taken as $27,000, approximately twice the amount spent by the Southern Pacific Co. Slight changes have been made in the amount for maintenance of stations, platforms, fuel-stations, and miscellaneous structures, because of elimination of certain facilities not needed in the composite system, making the total allowance for these items of about $4500 less than that given by the Southern Pacific Co. The total allowance for maintenance of way and structures is $221,568.

In computing maintenance of equipment, the cost per car-mile for the small passenger-cars has been taken as the same as for the present Key Route cars, namely, 1.014c. per car-mile. For the large cars the cost has been taken as proportional to the weight of the cars or 1.3c. per car-mile. For maintenance of electrical equipment, the same cost for the small motors as now obtains with the Key Route cars has been used, namely, 0.23c. per car-mile. For the large cars, the unit cost has been increased in proportion to the weight of the motors. The total allowance for maintenance of equipment is $105,700.

During the year 1916 the Key Route used 10,760,900 kw-hr. of power per year and the Southern Pacific Co. 28,596,958 kw-hr. For the car movements computed as already explained, it is estimated that the composite system would have used 29,216,598 kw-hr. The car mileage figures are as follows: Key Route, 2,960,357; Southern Pacific Co., 4,398,072; composite system, including street-cars, 6,256,658. Kilowatt-hours per car-mile: Key Route, 3.635; Southern Pacific Co., 6.5; composite system, 4.6696. Kilowatt-hours per ton-mile: Key Route, 0.101; Southern Pacific Co., 0.112; composite system, 0.112. It is interesting to note the close agreement in kilowatt-hours per ton-mile for the different systems. The allowance for cost of power is $190,621, based mainly on actual costs for the Southern Pacific Company.

The allowance for conducting transportation is $637,339, based mainly upon actual costs for the Southern Pacific Co. The cost per train trip is as follows: Key Route, $1.176; Southern Pacific Co., $1.844; composite system, $1.79. The cost per car-trip is: Key Route, $0.678; Southern Pacific Co., $1.068; composite system, $0.78.

The accompanying schedules have been prepared for the operation of the ferry-boats, using three boats on full time, three boats additional during the rush-hours, and one relief boat. In Table I, the figures 1, 2, 3, 4, 5, and 6 refer to trips rather than to particular boats. In Table II, the letters refer to particular boats. Boat D is the relief-boat. Its time is segregated according to the various other boats that it relieves. As will be seen from Table III of the actual performance of the Southern Pacific boats, one boat was out of service for repairs and overhauling 4 weeks and another 6 weeks during the year. In the proposed schedule two of the regular boats are out of service 8 weeks, while the part-time boats used during the rush-hours are out of service 4 weeks.

TABLE I. TRIPS AND MILEAGE.

Boat schedule	Monday to Friday	Saturday	Sunday	Total trips per week	Total annual mileage
1	40	40	38	278	50,736
2	38	38	36	264	48,181
3	32	36	34	230	41,972
4	 4	2	..	22	4,018
5	 4	2	..	22	4,018
6	 2	1	..	11	2,009
					150,934

TABLE II. BOAT PERFORMANCE.

Boat	Weeks in service	Weeks for inspection and repairs	Miles run	Schedule number
A	44	8	42,952	1
B	44	8	40,785	2
C	42	10	33,922	3
D	8	14	24,000	1
D	8	..	.....	2
D	10	..	.....	3
D	4	..	.....	4
D	4	..	.....	5
D	4	..	.....	6
E	48	4	3,710	4
F	48	4	3,710	5
G	48	4	1,855	6
	312	52		

TABLE III

ACTUAL PERFORMANCE OF SOUTHERN PACIFIC BOATS DURING 1916

Boat	Weeks in service	Weeks out of service	Miles run
Alameda	46	6	40,457
Santa Clara	48	4	42,971
Newark	42	10	37,326
Piedmont	46	6	38,356
Berkeley	35	17	31,173
Oakland	36	16	29,349
Bay City	8	44	5,550

The ferry expense is in general based on the Southern Pacific Co. figures, one-third of the expense being allotted to the steam-lines. This is based on the fact that it would be possible, although difficult, to handle the steam-line traffic with one full-time boat and one relief-boat. In computing the commissary expense, certain overhead costs were found to be a function of the number of boat-miles, while the cost of food, etc., was a function of the number of passengers carried. The actual cost of boat-repairs for the past five years has been determined from the Southern Pacific Co. records, and 10% added for overhead. The total cost of ferry operation is computed to be $634,363.

In computing depreciation the following methods were used:

Parts of the property that are maintained at their full value from year to year were not depreciated, provided such maintenance charges appear in the operating expenses. For other parts of the property, the sinking-fund method was used, interest being figured at 6%. The cost of grading the terminal was amortized over the life of the franchise. Roadway and terminal structures were given a life of 30 years. Track specials, less salvage

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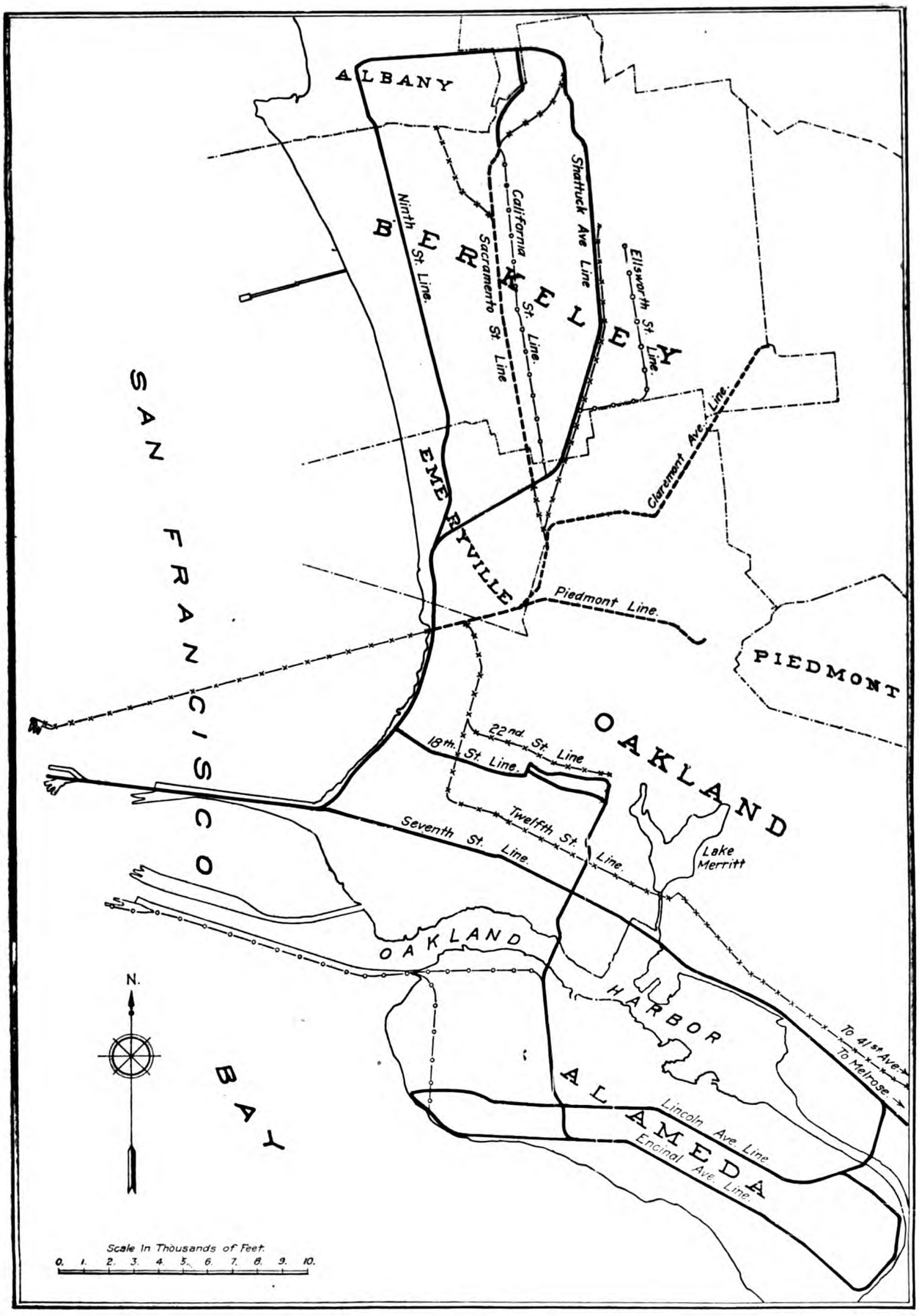

MAP OF EAST BAY CITIES, SHOWING LINES USED AND ELIMINATED

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value, ballast, paving, part of the trolley cost, and miscellaneous expenditures were given a 15-year life. Rails and tie-plates, less salvage value, track-laying, surfacing and bonding track, bridges, and culverts, signals and interlockers, telegraph and telephone lines, stations and waiting-rooms, roadway buildings, and part of the trolley and miscellaneous expenditures were given a 30-year life. Rolling stock was given a 30-year life. Ferry-boats have been given a 40-year life. Power-plant valuation has been based on the Southern Pacific records. Power-plant buildings, sub-station buildings, power-transmission system, and underground conduits have been given a life of 50 years. Power-plant machinery, sub-station apparatus, and the poles and fixtures for the power-lines, have been given a life of 30 years.

On this basis the summary of investment, revenues, and expenses for the composite system is as follows:

VALUATION OF PROPERTY

Land for transportation purposes	$1,100,000
Way and structures	7,161,000
Rolling equipment	3,098,300
Floating equipment	1,436,123
Power-plant and equipment	2,107,583
Total investment	$14,903,006

REVENUE

Passenger revenue	$2,641,356
Credit for half-fares to employees	27,275
Dining and buffet	450,696
Miscellaneous sources	39,069
Total	$3,158,396

EXPENSE

Maintenance of way and structures, including depreciation		$312,353
Maintenance of equipment, including depreciation		145,038
Cost of power, including depreciation		190,621
Conducting transportation on rail-lines		637,339
Ferry-operation, including depreciation		634,363
General (5%)		95,981
Total operating expense	$2,015,595	
Net operating revenue	1,142,801	
State taxes (5.25% of receipts)	$166,520	
Franchise taxes	46,601	
Total fixed charges		213,121
		$929,680

This represents a return of 6.24% on the investment.

Studies were also made of the necessary equipment that would be required to handle efficiently an increase of traffic of 10%, 20%, and 50% over that of 1916, together with the increased cost of maintenance and operation of the system for each increase of traffic. Using the prices of material and labor prevailing in 1916 the statement of investment, revenues, and expenses would be as follows:

VALUATION OF PROPERTY

	Increase of traffic of		
	10%	20%	50%
Land for transportation purposes	$1,100,000	$1,100,000	$1,100,000
Way and structures	7,161,000	7,161,000	7,161,000
Rolling equipment	3,228,428	3,411,228	4,068,070
Floating equipment	1,436,123	1,836,123	1,836,123
Power-plant and equipment	2,107,583	2,107,583	2,107,583
Total	$15,033,134	$15,615,934	$16,272,776

REVENUE

	Increase of traffic of		
	10%	20%	50%
Passenger revenue	$2,905,492	$3,169,628	$3,962,034
Credit from steam-lines for half-fare commutation tickets	27,275	27,275	27,275
Station and train privileges	18,500	18,500	18,500
Rent of parcel-room	360	360	360
Rent and miscellaneous receipts	4,500	4,500	4,500
Boat privileges	15,709	15,709	15,709
Dining and buffet	493,512	536,328	664,777
Total	$3,465,338	$3,772,300	$4,693,155

EXPENSE

	Increase of traffic of		
	10%	20%	50%
Cost of power	$195,577	$206,633	$244,757
Maintenance of way and structures	316,013	322,115	340,326
Maintenance of equipment	150,006	155,714	173,683
Conducting transportation	644,001	693,760	746,165
Ferry operation	656,262	694,689	785,627
General (50%)	98,093	103,646	114,528
Total operating expense	$2,059,952	$2,176,557	$2,405,086
Net operating revenue	1,405,386	1,595,743	2,288,069
Franchise tax	50,965	55,481	69,029
State tax (5.25%)	181,930	198,046	246,390
Net income	$1,172,491	$1,342,216	$1,972,650
Return on investment, per cent	7.8	8.6	12.1

THE LAMBERT CONFORMAL CONIC PROJECTION

The Department of Commerce announces the publication by the United States Coast and Geodetic Survey of Serial No. 77, Special Publication No. 47, 'A Manual on Lambert's Conformal Conic Projections, with Two Standard Parallels,' by C. H. Deetz. This is the projection of the official map of France and is used in the war zone for the new battle-maps, displacing the Bonne system of projection heretofore employed by that country. The manual is issued in response to calls for information on the subject from several departments of the Government, as well as from outside sources. It comprises about 61 pages, illustrated by 14 figures and 7 descriptive plates. Besides a description of the projection, the mathematical development of its formulas, and the French system of kilometric squares in topographic mapping, there is included a comparison of the Lambert with the Boone and with polyconic systems of projection. Copies of the publication may be obtained at 75c. each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The Lambert projection offers advantages in the mapping of countries of predominating east-and-west dimensions. Its meridians being straight lines, and its parallels arcs of concentric circles, the projction is well adapted to indefinite east-and-west extension, a property belonging to this general class of single-cone projections, but not found in the polyconic where adjacent sheets have a 'rolling fit' because the meridians are curved in opposite directions. For a map of the United States, the maximum error in scale is reduced from 6½% in the polyconic to 1⅛% in the Lambert projection. The merits and defects of these two systems of projection are in opposite directions. A study of the shapes and extent of any areas to be mapped, therefore, is the deciding factor in the choice of a projection to meet the requirements that a map is to fulfill.

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Design of the Engine for Class B Military Motor Truck*

By A. F. MILBARTH†

The designers of the military truck expected to limit the interchangeability of parts to the complete units, such as engines, axles, and transmissions. Several meetings of parts-makers were held to determine the degree to which their regular products could be standardized so as to make them interchangeable in the chassis. In the case of the engines, a standard set of dimensions could be determined, which necessitated only slight changes for the various manufacturers. This would have made it possible to replace a damaged unit with one of another make, in case none of the original type was available. However, the farther this work progressed the more the War Department was convinced that not only should complete units be interchangeable but also component parts of the units. This plan will reduce greatly the number of parts necessary for maintenance of the trucks at the front. When this decision had been made, the engineers of various parts-manufacturers were called to Washington to prepare suitable designs to meet the requirements of the Government.

Torque and Piston Displacement. The division in charge of the engine design was required to develop an engine with a torque-output of at least 2800 lb-in., which was necessary to give the tractive factor predetermined for these trucks. An average of the performance of various engines built in the past showed a torque of about $6\frac{3}{4}$ lb-in. per cubic inch of piston displacement. Using this figure as a basis, the piston displacement of the Class B engine was determined as about 415 cu. in. Possibly the most important consideration in the design was that of keeping the wearing parts of these engines large so that adjustments and replacements of parts would seldom be required.

Stroke and Bore. It was considered desirable to keep the stroke-bore ratio as high as possible, without obtaining either too great a total weight of engine or too great a height over-all. The length of stroke was therefore the deciding factor in determining the stroke-bore ratio. A 6-in. stroke was finally adopted. This with a bore of $4\frac{3}{4}$ in. gives a piston displacement of 425 cubic inches.

Engine Speed and Valve Diameter. The normal speed of these engines was set at 1050 r.p.m., which with the 6-in. stroke gives a piston speed of 1050 ft. per minute. The speed of maximum horse-power was also predetermined at about 1500 r.p.m. Past practice showed that the maximum horse-power of an engine is developed when the theoretical gas-velocity through the valves is about 14,000 ft. per minute. Assuming an engine speed of 1500 r.p.m., the valve area should therefore be:

$$(4\tfrac{3}{4})^2 \frac{\pi}{4} \times \frac{1500}{14000} \text{ or } 1.9 \text{ sq. in.}$$

This requires a valve $2\frac{1}{8}$ in. diam. in the clear, $2\frac{3}{8}$ in. outside diam, 45° seat, with a lift of 11/32 in. At the normal engine speed this will give a gas velocity of 160 ft. per second through the valve.

Compression Ratio. For the heavier grades of gasoline now in use the compression must be carried somewhat lower than was possible a few years ago, or serious pounding will result in the cylinders. The displacement per cylinder also has some effect on the compression, since a large cylinder has a smaller wall-surface cooling-effect per cubic inch of charge than a smaller one. A clearance volume of $24\frac{1}{2}$ to 25% of total volume was selected.

Connecting-Rod and Piston. The connecting-rod of the military engine is $13\frac{1}{4}$ in. long, or 2.21 times the stroke. Standard practice varies from 2 to 2.2 times the stroke. Both upper and lower bearings are designed central with the rod. The rod is of I-beam section. The upper end is bronze-bushed for the piston-pin, while the lower end is of the four-bolt type. The piston is $6\frac{1}{8}$ in. long, with three $\frac{1}{4}$-in. rings of the conventional type, with 45° saw-cut. The piston-pin is $1\frac{3}{8}$ in. diam. and is $2\frac{5}{8}$ in. from the lower end of the piston. A single lock-screw holds the piston-pin in place.

Crank-Shaft Design. The crank-shaft is of the conventional three-bearing type. While the governed speed of the engine was to be 1050 r.p.m., the designers wished to keep the stresses and bearing pressures low even at 1500 r.p.m. All calculations were therefore made at this higher speed. The stresses considered were three: Those due to gas-pressure, to inertia, and to centrifugal forces. The normal gas-pressure at beginning of power-stroke is assumed to be 280 lb. gauge, and the expansion curve to follow the equation $p\,r^{1.3} =$ constant. In the calculation of inertia forces the reciprocating weight was taken at 10 lb., including the piston, which weighs $6\frac{1}{4}$ lb., and the upper end of rod, with wristpin, weighing $3\frac{3}{4}$ lb. The centrifugal force is caused by the lower end of the rod with bearing weighing $5\frac{1}{2}$ pounds.

The crank-pins of the Class B engine are $2\frac{3}{8}$ in. diam. and 3 in. long. Deducting for fillets at each end, this gives a projected area of 6.53 sq. in. The maximum pressure on the pins is 520 lb. per square inch, the minimum 160 lb., and the mean 330 lb. At 1050 r.p.m. the centrifugal and inertia forces are: $(1050/1500)^2$ or 49% of the forces at 1500 r.p.m. At this speed the forces

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due to gas-pressure on the expansion stroke predominate. The maximum crank-pin load is then 512 lb. per square inch. In the calculation of main-bearing pressures there must be added to the above forces the centrifugal component of the short crank-arm and a crank-pin.

Bearing-Pressures. In order to decrease the number of spare parts, only two sizes of bearings are used on the crank-shaft. The connecting-rod and front main-bearings are interchangeable, likewise the centre and rear main-bearings, which are 2½ in. diam. and 4 in. long. Allowing for fillets, this gives a projected area of 9.375 sq. in. The pressures on the front main bearing (in pounds per square inch) are 727 lb. maximum, 32 lb. minimum, and 509 lb. mean. The centre bearing takes the load from two cranks at the same time. When No. 2 cylinder is on the suction-stroke, No. 3 is on the power-stroke; when No. 2 is on compression, No. 3 is exhausting, and vice versa. The forces from the two must therefore be combined to obtain the pressure on the centre bearing. The result (in pounds per square inch) is a pressure of 903 lb. maximum, 485 lb. minimum, and 695 lb. mean.

The rear bearing carries about the same load as the front, plus the weight of the fly-wheel. The fly-wheel load is almost negligible, however, as it amounts to less than 15 lb. per square inch. The maximum pressure on the rear main bearing is 492 lb. per square inch, the minimum 38 lb., and the mean 355 lb. At 1050 r.p.m. the main-bearing pressures are also considerably less than at 1500 revolutions per minute.

As might be expected, because of the liberal dimensions of crank-pins and main bearings, the fibre stresses in the shaft are low. The crank-arms are of heavy design also, in proportion to the pins, so that the maximum stresses, from combined torsion and bending, are less than 10,000 lb. per square inch.

Cylinder Construction. The cylinders are cast in pairs, of the L-type, with valves on the right-hand side. The heads are removable and held in place by 13½-in. studs. The valve-stems are enclosed by pressed-steel cover-plates. The water-jackets are thick, tapering from ½ in. below to 1¼ in. above. The spark-plugs are screwed directly into the cylinder-heads and are entirely surrounded by water. Cooling-water enters the jackets at the lowest point and leaves the heads at the highest point. No drain-cocks are necessary, the entire cooling system draining to one point.

Crank-Shaft and Fly-Wheel. The crank-shaft is of cast aluminum and is deep and well ribbed. The parting line between upper and lower half is 3 in. below the centre-line of the crank-shaft.

The fly-wheel is enclosed in a Society of Automotive Engineers bell-housing. Three-point suspension is employed, two arms cast on the bell-housing and a trunnion-bearing on the front gear-cover. Shouldered studs with castle-nuts are used for attaching the cylinders. Provision is made for the mounting of electric starters. Generators are mounted as regular equipment. The front gear-cover is of cast-iron and is well ribbed because it serves as a forward support. The lower half of the crank-case forms the oil-pan, and it entirely encloses the oil-pump.

Cam-Shaft and Gears. The cam-shaft is drop-forged with integral cams and flange for mounting the driving gear. The cams are 1⅜ in. diam., with 11/32-in. lift. The timing is as follows: Inlet opens 15° past top centre and closes 35° past lower centre; exhaust opens 45° before lower centre and closes 5° past top centre. The cam-shaft bearings are a trifle larger than the cams, so that the shaft can be withdrawn easily.

The timing-gears are 1¼ in. wide, with 9 pitch-teeth cut on an angle of 27¼°. The drive is from the crank-shaft gear through an idler to the cam-shaft and water-pump gears, and from the cam-shaft to the generator-drive gear.

The valve-tappers are hollow, 1⅛ in. diam., of the roller type. They carry adjusting-screws 1 in. diam., also bored hollow.

Oiling System. The oiling system is of the force-feed type, embodying a gear-type circulating-pump. No oil-pipes are used, the oil being forced through a passage drilled in the pump-body to a header extending the full length of the crank-case, then through drilled passages to the main bearings. Grooves are provided in the main bearings, which are in constant communication with the oil-holes drilled through the crank-shaft connecting-rods. Oil-tubes on the connecting-rods lead oil to the piston-pins. A relief-valve set for 10 lb. pressure is fitted to the front end of the main oil-header. The overflow from this valve lubricates the gears. The oil-pan or lower half of the crank-case is formed so that the oil will drain toward the centre of the sump, even though the engine is inclined, as in climbing or descending a hill.

The oil drains from the crank-chamber through a spout into a settling-chamber, where any water or mud settles, and can be drained from time to time. As the oil rises in the settling-chamber it finally overflows the top into a large strainer, which completely surrounds the settling-chamber. Through this strainer the oil flows by gravity into the sump proper.

The oil-pump is supported from the upper crank-case and extends into the sump. Another strainer surrounds the oil-pump, so the oil is thoroughly cleaned.

Methods of Ignition. Two independent systems of ignition are used; a high-tension magneto, which is driven from the rear end of the water-pump shaft, and a combined timer and distributer with coil mounted at the forward end of the engine, on the left-hand side, and driven through helical gears from the water-pump drive-shaft. Two sets of spark-plugs are fitted into the heads of the cylinders, and the engine can be run on either one or both of the systems.

Inlet and Exhaust Manifolds. The inlet and exhaust manifolds are on the right-hand side of the engine. A

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heating-chamber is cast integral with the inlet manifold near the centre and where the vertical branch from the carbureter joins the horizontal section. This heating-chamber is bolted directly to the exhaust manifold at a point where an opening is cast in the latter, so that the hot gases can circulate around the inlet manifold. This forms a hot spot 4 to 5 in. long, which helps to vaporize the fuel and permits the use of low grades of gasoline.

Fan for Cooling-System. A 22-in. fan is mounted on a rigid bracket, bolted to the crank-case. The fan is provided with a vertical adjustment for taking up the slack in the belt.

Engine-Governor. An enclosed governor, driven from the forward end of the generator-shaft, is built into the engine. The centrifugal members of this governor consist of four 1-in. steel balls, held in place by a spider. The governor revolves at about one and one-half times engine speed. The thrust from the balls is 34 lb. On their outward movement these balls travel against the face of a 45° disk, which also gives the balls a longitudinal movement against a collar free to slide on the governor-shaft. The collar has a movement of $\frac{3}{16}$ in., which is transmitted through a vertical lever, multiplying the movement threefold. A link with ball-joints connects the upper end of the lever with a throttle-spindle in the inlet manifold. A spring is fitted to the vertical lever, and an adjustment with a seal is provided.

Land Leveling With Tractors on the Truckee-Carson Project*

By F. N. CRONHOLM

On the various Government projects there is 1,760,000 acres of land to which the Government is prepared to supply water. Of this area 600,000 acres is not cropped. The principal reason for this condition is that the land is rough and requires considerable labor for preparation before cultivation can be attempted. To stimulate settlement of this acreage and to assist present settlers the Government is starting a campaign of land preparation.

Leveling land is as distinct from farming as is successful crop-marketing. Farmers engaged in reclamation pioneering seldom have sufficient capital to enable them to level rough land properly. Some land has a sufficiently even slope to make the work of preparation slight. Such land is placed under cultivation without difficulty. Lands that are now settled but not under cultivation, as well as lands that are open to settlement but not entered, are the roughest lands.

The plans of the Reclamation Service are to level the lands roughly so that the problems of today's settlers will be no more difficult than those of the first settlers on the better lands. This requires a study of farm arrangement and of proper water distribution, and will result in the elimination of non-productive areas and in more production per acre.

Before work of rough leveling is started a topographic survey is made of the tract. This is used in part to determine the position of the main and lateral ditches and drains but mainly to determine the direction of slope to be given the lands that are to be leveled. Where the general slope is hard to determine with the eye, 0.5-ft. contours should be taken, when the slope is more pronounced intervals of 1 ft. are ample, and where the tract as a whole has a pronounced slope 2-ft. contours are sufficient.

After the topographic sheet has been prepared, each farm unit is studied in the field, and the plan of rough leveling outlined. As far as practicable the direction of irrigation is made to agree with the slope of the land. The slope of areas as small as 5 acres is considered. In most cases the plan permits sub-division of farms into units as small as 20 acres without materially affecting the scheme of water distribution.

The 'border-check' method of irrigation is growing in favor in many parts of the country and is used almost exclusively on the Truckee-Carson project wherever lands are properly prepared or cropped. For this reason we do not take advantage of small level areas on farm units and make compartments or basins of them. We divide the lands so leveled into strips by building low, wide, parallel levees running with the slope, and 60 to 70 ft. apart. The slope of lands between levees, where soils are light, should not be less than 0.2 ft. per 100 ft.; on heavier soils about 0.1 ft. per 100 ft. is allowed as a minimum. The length of strips is from 330 to 660 ft., depending on topography and the economic arrangement for farm-laterals and for the removal of surplus irrigation-water.

Where the slope is steep, up to 3 ft. per 100 ft., depending somewhat on the soil, it is possible, after a crop has been started, to use the border-check system of irrigation. However, to get a stand and to avoid washing out the seed it is advisable after seeding to corrugate or furrow the lands between levees and to use this method of irrigation until a fair growth has been attained. Where soils are porous and the percolation is so great that water will not find its way through the length of furrow, the length of run can be cut in two by providing a temporary supply-ditch. This ditch can be eliminated afterward, water being supplied from the ditch at the head of the land, and the furrows and strip being flooded as is the general practice with the 'border-check' method.

*Abstract from 'Reclamation Record'.

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When the land between levees is being finished by the farmer he should keep in mind the importance of making the first 30 ft. of the strip level in all directions. This permits uniform distribution of water over the entire width of the strip before the water starts to run down the slope.

For the sandy-loam surface-soils and the small amount of slope on the land that we are now working, it is advisable to provide 20 second-feet of water as an irrigation-head for each farm-unit of 80 acres. We advise the construction of laterals to handle this amount and sub-laterals to handle 10 second-feet. The right amount of water for a given surface and subsoil cannot be predetermined exactly, but from 5 to 10 second-feet will be used in each strip or check on porous soils and perhaps half that amount on clay soils. Small ditches are often the cause of under-production and of drainage difficulties, since they encourage the continuous-flow system, which has been found on this project to be far more injurious and wasteful than are too large irrigation-heads in the rotation system.

In preparing a farm unit for rough leveling, the prevailing slope, possible water-surface elevations, and the ditch and drainage system should all be considered. After these factors have been determined roughly and the farm is plowed to agree with the general scheme of the tract, a line of levels is run around a 5, 10, or 20-acre part of the unit, the size of the tract depending on the general slope. Stakes are then set at the lower and upper end of the land as guides for the tractors doing the leveling. The land is plowed first, but not disked. The sod crumbles under the weight of the equipment, and as the shaping of the land progresses, the lumps disappear. In fact, sandy lands do not need to be plowed at all. The land is generally divided into square or rectangular strips arranged so as to give the minimum ditch-length. The final leveling and shaping of the land is done by the farmer at the time the levees and ditches are constructed. This work is usually done with fresno scrapers.

Even this arrangement leaves the farmer plenty to do after he has gone on his land. He will have to build shelter for himself, his stock, and his equipment, bore a well, do the final leveling, and build ditches, levees, tail-water drains, irrigation structures, and fences.

During the summer of 1917 we operated only two tractors on the Truckee-Carson project, mainly as an experiment and to determine the costs of preparing the land. We have recently ordered three more, and intend to work on a much larger scale; in fact, we have devised a flood-lighting system for working the machines 24 hours per day. If this proves to be practical, we will be able to level about 500 acres per month, or about 300 acres if the tractors are worked only 16 hours per day.

The two machines we now have worked 16 hours nearly every working-day through the season. The average amount of rough leveling has been 126 acres per month, including all lost time. The average cost has been as follows:

	Per acre
Operation of plant and equipment	$18.50
Depreciation of plant and equipment	5.00
Engineering	1.50
General expense	3.75
	$26.75

To this must be added the $6 per acre for plowing, making the total cost $32.75 per acre. This includes several plowings on some land.

In the tract where work is being done there are thirteen 80-acre units. Some leveling has been done on nearly every unit. As the remaining acreage is noticeably rougher than that leveled we assume that when the tract is done the average cost will be about $40 per acre. So far we have worked only on un-entered public lands. The leveling of uncultivated settled lands has been considered but no decision has been reached; in fact, the terms at which the Government will require the return of the cost for rough leveling have not yet been determined.

The number of automobiles including trucks produced in the United States in 1917 was 1,814,988, as compared with 1,485,917 in 1916. There are now about 4,400,000 passenger-automobiles and 435,000 trucks in the United States. There are about 720,000 automobiles of all kinds in the rest of the world. The following tables show the relative popularity of certain construction-features:

	Total, %	
	1917	1918
Cylinders:		
Four	36	33
Six	47	50
Eight	13	13
Twelve	4	4
Clutches:		
Disk	70	74
Cone	30	70
Cooling system:		
Thermo-siphon	36	32
Centrifugal pump	64	68
Oiling system:		
Force-feed	22	24
Force-feed and splash	54	58
Plain splash	24	18

X-ray photographs may be used to determine the internal condition and deterioration of reinforced concrete. Photographs of slabs several inches thick have shown the condition of the concrete and also of the reinforcing-rods. The injection of a bismuth solution under pressure helps to determine the existence and position of even fine cracks.

Potash may be obtained in considerable quantities from the flue-dust of blast-furnaces. A writer in the 'Mechanical World' estimates that 15,000 tons per year could be produced from this source in Great Britain, nearly as much as the normal pre-war consumption for agricultural purposes.

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Costs of Highway Construction in California

The financing of highway construction is a particularly important problem at the present time. The general policy of the Federal Government officials is to approve projects where it can be shown that the proposed highway is a war necessity that will yield immediate returns commensurate with the expenditure, and not to approve any other projects. At the same time the cost of labor and materials used in highway construction has increased materially. To assist in determining probable costs of construction on the Pacific Coast during the coming season, the following summary of bids received recently by the California State Highway Commission has been prepared. The figures in parentheses indicate the following contractors:

(1) W. B. Arndt, San Francisco.
(2) Erickson & Peterson, San Francisco.
(3) Federal Construction Co., San Francisco.
(4) Palmer & McBryde, San Francisco.
(5) P. F. Reilly, San Francisco.
(6) F. Rolandi, San Francisco.
(7) Bates & Borland, Oakland.
(8) George S. Benson & Sons, Los Angeles.
(9) Edward Gyles, Los Angeles.
(10) W. N. Hendricks and M. S. Cummings, Los Angeles.
(11) W. M. Ledbetter, Los Angeles.
(12) A. L. McCray, Los Angeles.
(13) Charles D. Soteras, Los Angeles.
(14) G. W. Tuttle Co., Los Angeles.
(15) Connors, Green & Co., Eureka.
(16) Humboldt Dredging Co., Eureka.
(17) Mercer-Fraser Co., Eureka.
(18) A. J. Fairbanks, Willits.
(19) Maurice Ryan, Campo.
(20) Fred Hoffman, Long Beach.
(21) David H. Ryan, San Diego.
(22) E. S. Groshong, Burbank.
(23) J. A. Marshall, Berkeley.
(24) Engineers' estimate.

On November 26, 1917, the following bids were received for grading 8 miles of highway in Mendocino county between Willits and Arnold:

Item and quantity	(24)	(5)	(6)	(7)	(1)	(2)	(18)
Excavation, 136,900 cu. yd.	$0.50	$0.84	$0.81	$0.74	$0.84	$0.74	$0.7875
12-in. pipe, 1582 ft.	0.50	1.00	0.70	1.00	1.00	0.60	0.70
18-in. pipe, 880 ft.	0.60	1.00	1.00	1.00	1.00	0.70	1.00
24-in. pipe, 388 ft.	0.80	1.00	1.20	1.00	1.00	1.00	1.50
Concrete in culverts and monuments, 430 cu. yd.	12.00	20.00	18.00	15.00	22.00	17.00	18.00
4-in. tile-drain, 1000 ft.	0.50	1.00	0.30	1.00	0.50	1.00	0.50
Moving and re-setting property-fences, 4 miles	200.00	300.00	300.00	300.00	250.00	275.00	250.00
Monuments, 262	0.50	1.50	1.50	1.50	1.50	1.00	1.25
Total	$88,170.96	$129,039.00	$122,975.00	$113,199.00	$129,199.00	$112,931.20	$119,945.65

The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $7095.26. The contract was awarded to Erickson & Peterson, for $112,931.20, making the total cost, $120,026.46, or $15,000 per mile. The cost of grading alone was $12,650 per mile.

On November 26, 1917, only one bid, from George S. Benson & Sons, was received for construction of 8 miles of highway in Monterey county between San Lucas and San Ardo. The prices named were as follows, the first figure being the engineers' estimate and the next the bid: excavation, 16,840 cu. yd., $0.55, $0.90; 12-in. pipe, 1000 ft., $0.60, $1; 18-in. pipe, 220 ft., $0.70, $1.10; 24-in. pipe, $0.80, $1.20; concrete in culverts and monuments, 280 cu. yd., $9.50, $17.50; concrete in pavement, $4.20, $5.10; pile jetty, complete, $1650, $3500; riprap in retaining-wall, 600 tons, $2.40, $5; slope-paving, 250 cu. yd., $4, $8; guard-rail, 2950 ft., $0.40, $1; monuments, $0.50, $2, making a total for the engineers' estimate of $58,851.48 and for the bid of $73,215.60. The State was to have furnished pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $55,002. The bid was rejected.

On this same date bids were to have been received for the construction of the highway in Butte county between Biggs and Nelson, but no bidders appeared.

On December 24, 1917, the following bids were received for the construction of 11 miles of highway in Monterey county near San Lucas:

Item and quantity	(24)	(7)	(8)	(4)
Excavation, 46,900 cu. yd.	$0.65	$0.85	$0.75	$0.90
12-in. pipe, 1160 ft.	0.50	0.60	1.00	0.90
18-in. pipe, 225 ft.	0.60	0.70	1.10	1.00
24-in. pipe, 85 ft.	0.70	0.80	1.20	1.10
Concrete in culverts and monuments, 376 cu. yd.	12.00	20.00	17.50	18.00
Concrete in pavement, 11,000 cu. yd.	5.50	5.10	5.30	5.75
Guard-rail, 3700 ft.	0.40	0.50	0.80	0.50
Monuments, 124	0.50	1.50	2.00	1.50
Total	$112,485.53	$106,442.50	$104,772.50	$115,626.50

The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $70,561. Contract was awarded to George S. Benson & Sons for $104,772.50, making the total cost $175,333.50, or $15,950 per mile.

On December 31, 1917, only one bid, that of Fred Hoffman, was received for construction of concrete pavement on 26 miles of highway in Los Angeles county between Quail lake and Kay ranch, on the 'Ridge road' between

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Bakersfield and Los Angeles. Rough grading on this road was done in 1915 and 1916. The prices named were as follows, the first figure being the engineers' estimate and the second the bid: concrete in pavement, aggregates obtained from northerly sources, 9000 cu. yd., $8, $16.70; concrete in pavement, aggregates obtained from southerly sources, 24,600 cu. yd., $10, $16.70; concrete in culverts and retaining-walls, 300 cu. yd., $15, $16.70; guard-rail, 12,000 ft., $0.58, $0.75, making a total of $378,879 for the engineers' estimate and $575,130 for the bid. The State was to have furnished reinforcing-steel and cement, valued at $140,878. The bid was rejected.

On January 7, 1918, W. M. Ledbetter was the only bidder for grading 3.7 miles of State highway in San Diego county near the Sweetwater river at the following unit prices, the first figure being the engineers' estimate and the second the bid: excavation, 55,250 cu. yd., $0.90, $1.25; 18-in. corrugated pipe, 1352 ft., $0.50, $1; 24-in. pipe, 644 ft., $0.65, $1; 30-in. pipe, 138 ft., $0.85, $1.25; concrete in culverts and monuments, 135 cu. yd., $14.50, $30.50; dry-rubble masonry in retaining-walls, 160 cu. yd., $2.80, $12; guard-rail, 500 ft., $0.50, $1; monuments, $1, $1.25, making a total of $64,526.88 for the estimate and $77,993.50 for the bid. This bid was rejected and new bids were received on February 18, as follows, the quantities and the engineers' estimate being the same as before:

Item	(13)	(19)	(12)	(11)
Excavation	$1.14	$1.06	$1.20	$1.275
18-in. pipe	0.60	1.00	1.00	0.80
24-in. pipe	0.70	1.00	1.00	1.00
30-in. pipe	0.80	1.00	1.00	1.25
Concrete in culverts and monuments	20.00	20.00	25.00	18.50
Dry-rubble masonry	3.00	3.00	3.00	5.75
Guard-rail	0.30	0.60	1.00	0.70
Monuments	0.60	1.50	1.00	1.25
Total	$67,795.40	$64,449.00	$72,969.00	$76,334.35

The State will furnish reinforcing-steel, pipe-railing, and corrugated pipe, valued at $4044.01.

Bids were to have been received in January for grading the highway in Modoc county between Adin summit and Canby, but no bidders appeared and no further action has been taken.

On January 21, David H. Ryan was the only bidder and was awarded the contract for construction of 4 miles of State highway in San Diego county through the municipalities of East San Diego and La Mesa at the following unit prices, the first figure being the estimate and the second the bid: excavation, 9600 cu. yd., $0.65, $1.50; 18-in. pipe, 170 ft., $0.60, $1; 24-in. pipe, 130 ft., $0.90, $1.50; concrete in culverts and monuments, 42 cu. yd., $15, $15; concrete in pavement, 4060 cu. yd., $6.70, $7.40; guard-rail, 416 ft., $0.50, $1; monuments, 38, $0.50, $1.50; making a total of $39,695.70 for the engineers' estimate and $45,912 for the bid. The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $17,560.20, making a total cost of $63,472.20, or $15,850 per mile.

On January 28, F. Rolandi was the only bidder for grading 15 miles of highway in Lassen county between Coppervale and Susanville at the following unit prices, the first figure being the engineers' estimate and the second the bid: excavation, 66,000 cu. yd., $0.75, $1.05; 12-in. pipe, 1750 ft., $0.60, $0.80; 18-in. pipe, 550 ft., $0.70, $1; 24-in. pipe, 550 ft., $0.85, $1.30; concrete in culverts and monuments, 400 cu. yd., $15, $20; new property-fences, 1.5 miles, $200, $300; moving and resetting property-fences, 0.5 mile, $200, $300; monuments, 308, $1, $1.50; making a total of $66,827.08 for the estimate and $81,027 for the bid. The State was to have furnished pipe-railing, reinforcing-steel, corrugated pipe, cement, and material for new fences, valued at $6950.20. The bid was rejected.

The following bids were received on February 25 for construction of concrete pavement on the highway in Santa Cruz county between Santa Cruz and a point 3 miles south of Glenwood, 6.7 miles. Rough grading on this road was done some time ago:

Item	(24)	(3)	(23)	(4)	(7)
Excavation, 12,000 cu. yd	$0.75	$0.75	$1.15	$1.10	$1.00
12-in. pipe, 208 ft	0.60	0.60	0.75	0.70	0.60
15-in. pipe, 24 ft	0.70	0.75	0.85	0.80	0.60
Concrete in culverts, 20 cu. yd	12.00	12.50	20.00	20.00	15.00
Concrete in pavement, 6600 cu. yd	5.00	5.93	7.65	7.35	6.65
Total	$48,738.84	$48,530.80	$64,866.40	$62,274.80	$56,329.20

The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $35,125.

The following bids were received March 4 for grading 6.2 miles of State highway between Eureka and Arcata in Humboldt county:

The State will furnish reinforcing-steel, corrugated pipe, and cement, valued at $3113.25.

Item and quantity	(24)	(17)	(4)	(16)	(6)	(15)
Excavation, 133,000 cu. yd	$0.28	$0.3175	$0.55	$0.475	$0.81	$0.70
24-in. pipe, 100 ft	1.50	2.00	0.75	1.00	1.00	1.00
Concrete in culverts and monuments, 320 cu. yd.	15.00	20.00	20.00	21.00	20.00	15.00
Monuments, 44	0.50	0.50	1.50	5.00	1.00	1.00
Total	$48,543.80	$48,849.50	$79,691.00	$70,215.00	$114,276.00	$98,044.00

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The following bids were received March 4 for construction of 1.9 miles of highway in San Diego county through the city of Oceanside:

Item and quantity	(24)	(22)	(14)	(10)	(9)
Excavation, 2600 cu. yd	$0.75	$0.90	$0.51	$0.90	$1.20
18-in. pipe, 266 ft	0.70	1.00	0.65	1.50	0.60
Concrete in culverts and monuments, 45 cu. yd	15.50	10.00	15.00	20.00	16.50
Concrete in pavement, 2035 cu. yd	6.00	6.25	7.76	9.20	10.24
Guard-rail, 112 ft	0.60	0.75	0.66	3.50	0.75
Monuments, 16	0.50	1.00	1.46	2.50	1.00
Total	$17,386.74	$15,874.75	$18,062.78	$22,793.00	$24,960.50

The State will furnish reinforcing-steel, corrugated pipe, pipe-railing, and cement, valued at $8618.36.

An examination of the above figures shows that 29 bids were received from 23 different contractors on ten contracts. On one of these contracts bids were received twice. On two other contracts, not included with the above ten, no bids were received. The largest number of bidders on any one contract was six. The contrast with the earlier years of State highway work, when as many as twenty bids were sometimes received on one contract, and seldom less than eight, is striking. Three of the contracts, the Modoc and Lassen county jobs and the work on the 'Ridge road' in Los Angeles, are situated at a considerable distance from either centres of population or railroad facilities. On one of these, the Modoc County job, no bids were received, and on the two others, only one bid on each contract. In both cases the bid was so much higher than the engineers' estimate that it was rejected. This would indicate that on work situated at a considerable distance from railroads, it may become necessary either to use convict labor or else to divide the work into such small units that the local people can bid on it as 'station-work.' Since such highway work is usually mainly grading of such a character that it can be handled economically by hand-labor without expensive equipment, such a course is more feasible than might be apparent at first sight. However, roads through this kind of country will seldom come under the Federal Government's classification of 'important links in main trunk-line highways or else roads that will facilitate the transportation of agricultural products,' and if they do not come in this class there is little hope of obtaining funds for their construction until after the War.

Turning now to bidding-prices, little comfort is afforded to those who may hope for highways constructed at a moderate cost. No classification is made of excavation on any of the work. Excavation without classification is an item in nine contracts, the lowest price named by any general low bidder being $0.3175 and the highest, $1.50, with an average of $0.91 per cubic yard. If the bid of $0.3175 named on the dredging work in Humboldt county between Eureka and Arcata is omitted, the average price is increased to $0.98 per cubic yard. The lowest bid on any other work is $0.74. A comparison with records given on pages 459 and 460 of the December 1917 issue of WESTERN ENGINEERING shows that on 32 contracts awarded between May and November 1917, the highest price was $1.05, the lowest, $0.39, and the average, $0.704 per cubic yard. On 26 contracts awarded between December 1914 and July 1915 the highest price was $0.70, the lowest, $0.30, and the average, $0.50 per cubic yard. Between July 1915 and May 1917, few contracts were awarded, as the proceeds of the $18,000,000 issue were nearly exhausted, and the proceeds of the $15,000,000 had not become available. It is possible that the more recent work happens to be somewhat more difficult than that awarded in the early part of 1915, but it is safe to say that the cost of excavation is now nearly twice what it was three years ago.

Concrete in culverts, the State furnishing cement, is an item in six contracts, the highest price being $20, the lowest, $10, and the average, $16.45 per cubic yard. On eight contracts awarded between May and November 1917, the highest price was $17.50, the lowest, $12, and the average, $14.94 per cubic yard. On nine contracts awarded between December 1914 and July 1915, the highest price was $16, the lowest, $7.50, and the average, $11.05 per cubic yard.

Concrete in culverts, the State furnishing all materials, is an item in three contracts, the highest, lowest, and average prices being $17.50, $12.50, and $15.80 per cubic yard, respectively. On 21 contracts awarded last year, the corresponding figures were $22, $6, and $12.34. On 19 contracts awarded three years ago the corresponding figures were $15, $6, and $10.10.

Concrete in pavement, the State furnishing cement, is an item in three contracts, the highest price being $16.70, the lowest $6.25, and the average, $10.12 per cubic yard. This $16.70 price, however, was named for the work on the 'Ridge road' in Los Angeles county, where conditions are unusually unfavorable. The work is from 5 to 30 miles from a railroad, and from 50 to 75 miles from a large city. The country traversed is practically uninhabited, and produces no food or other supplies. Water for most of the work must be pumped or hauled up-hill for a considerable distance. Aggregates also are difficult to obtain. If this $16.70 bid is omitted, the average is reduced to $6.83 per cubic yard. On three contracts awarded last year the average price was $6.43 per cubic yard. On five contracts awarded three years ago, the highest, lowest, and average prices were $6.15, $3.49, and $4.41 respectively.

Concrete in pavement, the State furnishing all ma-

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terials, is an item in three contracts. The range in prices is small, the highest being $5.93, the lowest, $5.10, and the average, $5.44 per cubic yard. On 22 contracts awarded last year, the corresponding figures were $6, $3.09, and $4.19. On 15 contracts, awarded three years ago, the figures were $4.25, $2.20, and $2.90. Labor costs on concrete work seem also to be nearly double those of three years.

On the other items included in the work, the quantities in proportion to the entire work were small and the bids variable, so that average figures would mean little or nothing. Two of the contracts awarded, 4 miles in San Diego county through the municipalities of East San Diego and La Mesa, and 11 miles in Monterey county near San Lucas, were for the complete highway including paving, and the grading was comparatively light, less than 4000 cu. yd. per mile in each case. The total cost for labor and materials was a little over $15,000 per mile for both jobs. This is probably close to the minimum cost for a highway built according to State Highway specifications at the present time. It should be remembered that this is not the entire cost, since it does not include the State Highway Commission's overhead nor the cost of the right-of-way, if any.

Hydraulic Sluicing for Blanketing Porous Canal Banks*

By R. B. STEVENS

The Pishkun canal, North Side system, Sun River project, Montana, diverts water from the north fork of Sun river at the eastern edge of the main range of the Rocky Mountains. After traversing about 12 miles of broken foothill country, it discharges into Pishkun reservoir, from which water is carried by the Sun River Slope and Greenfield canals to 65,000 acres of benchland north of Fort Shaw. The canal as now constructed has a bottom width of 27 ft., side slopes 1½ to 1, normal water depth, 11 ft., and capacity 1000 second-feet. It is built through several stretches of broken seamy rock and coarse gravel. It is impracticable to depend upon ordinary silt-deposition to close the open spaces in this material because the north fork of Sun River carries only a small amount of silt at high water, and practically none during the rest of the season. Some plan of artificial silting was, therefore, necessary if large losses of water were to be avoided.

The original plan was to place electrically-driven pumping plants at various points on the upper slope of the canal, wherever suitable material could be found, and to ground-sluice this material into the canal so that it would be carried down the canal in suspension and be deposited gradually over the sides and bottom. Two difficulties became apparent when this plan was tried; first, the limited wasteway capacity at the lower end of the canal made it necessary to check at the various regulating structures in order to secure the required depth of water; and second, there was no material near the canal sufficiently fine to be held in suspension for any considerable distance from the sluicing plant. Long-distance silting was, therefore, abandoned in favor of using fine material on the rocky slopes of the canal, depositing this material at nearby points where the leakage was heaviest.

One of the first and most obstinate leaks appeared at mile 4.3, where the loss was 10 second-feet in a 1600-ft. stretch of canal when the depth of water in the canal was only 18 in. This part of the canal was in broken sandstone with open seams, where bad ground-conditions had been made worse by careless blasting. Two centrifugal pumps were placed just above the leaking section, one a 2-in. pump direct-connected to a 5-hp. motor, and the other a 4-in. pump belt-driven by a 10-hp. motor. A 4-in. pipe-line with a nozzle was attached to the discharge of these pumps, and the fine material among the rocks was washed out and carried down the slope into the canal. It soon became apparent that this method was unsuited to the class of material available, as it settled to the canal-bottom before it had traveled more than 300 ft. This plan was abandoned. Another pit of finer material situated about 300 ft. from the canal was opened. The same equipment was used to loosen the material, but it was carried to the canal through a 16-in. galvanized sheet-iron pipe (this pipe being used because it was available on the project) laid on the ground and carried across the canal by a flume supported on a raft. There were side-openings at regular intervals in the flume. This method, although better than the first, was far from satisfactory, as the coarseness of the material caused it to sink within a short distance. Sluicing for even a relatively short distance was then abandoned in favor of local work.

The flume on the raft was extended to and along the canal-bank with gate-controlled side-openings toward the bank. With this arrangement it was possible to place a blanket of fairly impervious material on the sides or bottom to any desired depth, and, by adjusting the height of the flume above canal-grade and the depth of water in the canal, the blanket could be spread over nearly the entire inside slope of the bank and part of the bottom. This plan was satisfactory. Work was continued until the loss in this part of the canal was reduced from 10 to 3.3 second-feet, while the depth of water in the canal was increased from 18 in. to 8 ft. When the depth of water was reduced to 3 ft., or twice the depth when work first commenced, the loss was only 0.1 of a second-foot.

At mile 3.2, another bad leak appeared in a stretch of

*Abstract from 'Reclamation Record'.

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heavy open gravel, where the canal had been constructed by a drag-line excavator. This section was treated in the same manner and the leakage greatly reduced. One difficulty at this point was the large proportion of gravel in the pit, which blocked the pipe and flume. This was overcome by sluicing out a basin into which the clay was carried before entering the conductor-pipe.

One of the worst leaks was in a 2000-ft. stretch below mile 1.3. This part of the canal was in coarse gravel overlying seamy shale. Part of the canal-water seeped out through the gravel, but the greatest loss was through the shale in the canal-bottom. The water re-appeared in springs along the river-bank, from 800 to 2000 ft. from the canal. Only part of the loss could be measured, but the maximum loss was estimated at 35 second-feet with a flow in the canal of 175 second-feet. Early in the season some material was hauled about 600 ft. in wheel-scrapers from a pit to a sluicing plant placed near the upper slope of the canal, dumped through a trap into a chute, and sluiced directly into the canal. This method proved impracticable. As the leakage did no damage to the canal itself, work was stopped temporarily in the hope that since this stretch was near the headworks it might silt from the river. As the water-level in the canal was raised through the summer, the leakage became so heavy as to demand attention. Late in the fall, after a considerable search, some suitable fine material was found above the canal at mile 1.0. Two 4-in. centrifugal pumps were placed, one direct-connected to a 20-hp. motor, and one belt-driven by a 10-hp. motor. Ground-sluicing was used as before. The sluiced material from both pumps was discharged into a common flume on a raft, with side-openings as before distributing the material across the canal. The lower end of the leaking section was 3600 ft. down the canal from the plant. The material for sluicing was hard to reach because it was situated among rocks and required loosening with dynamite. Nevertheless this method proved to be satisfactory. After 10 days' sluicing, the surface-leaks were reduced from 4.5 to 0.6 second-feet with a marked reduction also in the underground losses. Work was then stopped for the winter but will be continued when larger heads of water are available.

About 35 measuring weirs were placed in the various drainage channels fed by canal-seepage. These were read at least twice a week, a record kept of the comparative losses, and current-metre ratings of the canal made at regular gauging stations. The differential results from canal gaugings were erratic, but the weir-records were an excellent index of seepage reduction.

Alternating current for pumping was available at 16,500 volts on a transmission line built along the lower side of the canal. Transformers stepping this current down to motor voltage were placed where needed and temporary connections made for each plant. Current was obtained from the Great Falls Power Co. at a sub-station near the headworks at 1 to 2½ cents per kilowatt-hour. The ordinary force employed for each plant was a pumpman at $4 to $4.40 per day and two assistants at $3.30 to $3.60. When the plant was working in good material that would not clog the flumes, only one assistant was needed. When moving the plant, a man and team were required. For future operations it is planned to mount the plant on a raft and thus reduce the moving cost considerably.

The costs of this work were high on account of the difficulty of securing the material in any large quantities, the cost of placing the electrical equipment for each move, and the high wages paid for labor. The cost of the sluiced material in place, exclusive of superintendence and general expense, was 71c. per cubic yard, place measurement, of which 29c. was for power, plant, etc., and 42c. for labor and teams. About 2500 cubic yards was excavated.

AMMONIA FOR FIRE EXTINGUISHING*

By A. SCHLEIMER

Combustion, in the sense that we use the word as applied to fire, depends entirely upon the supply of uncombined oxygen obtainable. The greater the quantity and quality of this gas, the more rapid and effective the fire. Naturally the supply of oxygen is obtained in the majority of cases from the atmosphere, which contains 23%, the remainder being mainly nitrogen. Oxygen is the greatest supporter of combustion; so great that in it we can burn such substances as iron, steel, and diamonds. Nitrogen, on the other hand, is the most inert element there is. Ammonia gas is composed of nitrogen and hydrogen. Notwithstanding the fact that hydrogen is itself combustible, when combined with nitrogen to form ammonia, it has a peculiar effect of suffocation on the respiratory organs and seems to exert a similar action on combustion. A little ammonia gas will go a long way toward extinguishing a good-sized fire. This is because it cuts off the air supply.

A building could be piped from a tank outside, containing ammonia, either in the liquid or gaseous state, so that the ammonia could be controlled by an outside valve or by means of fusible alloys. The pipes should be run on or under the floor instead of at the ceiling, for the reason that ammonia rises, whereas if it were at the ceiling it would have a tendency to remain there, and would take some time for diffusion, especially in the case of a higher temperature. The outlet pipes should be clear at all times, which could be accomplished by having them end in a tee, with one open end of the tee larger than the other, and the smaller opening uppermost, which would prevent any possibility of clogging up with dirt. Two advantages that the use of ammonia has over water are that the fire can be extinguished more rapidly, and that the work will be done by a gas that can be removed by ventilation and which has little or no effect on most substances, eliminating the enormous loss that is frequently caused by water alone.

*Abstract from 'Machinery.'

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High-Temperature Resistance Furnaces

By W. E. RUDER

*In 1911, Winne and Dantsizen described two forms of resistance furnaces using ductile molybdenum or tungsten as resistors. Since the discovery, in the research laboratory of the General Electric Co., of methods for producing these metals in ductile form, their use as resistance elements has grown to such an extent that they are now almost indispensable. These furnaces are used for alloy research, annealing, heat-treating, and practically all of the thermal processes requiring temperatures above 900°C. Various types of furnaces have been developed to meet other needs of laboratory work. A tubular furnace, wound with a metallic resistor, is the simplest type to construct, and almost every laboratory has such furnaces. The only essential difference between a furnace wound with platinum or a base metal and one wound with tungsten or molybdenum is that the coils of the latter must be heated in a neutral or reducing atmosphere. It has long been the custom in the G. E. laboratory to build resistance furnaces with a metallic casing from which the tube could be easily removed for re-winding. The heat-insulating material, usually calcined magnesia, alumina, silica, or silex, depending upon the nature of the resistor, is used in powdered form so that it can be removed and replaced readily. In order to adapt this method to tungsten or molybdenum windings, it was necessary to make the casing gas tight and to provide it with an inlet and outlet for the neutral or reducing gas. On account of its greater pliability in heavy sections, molybdenum is commonly used for the windings. Its melting point (about 2550°C.) allows for a sufficient range above the softening temperatures of available refractories to make it unnecessary to employ the higher-melting tungsten. This holds true when resistors are run at atmospheric pressures; if, however, it be desired to run at reduced pressure or in a vacuum, tungsten is used, because the high vapor-pressure of molybdenum renders it unsuitable, and because a much higher temperature is available. The resistance of tungsten at 25°C. is 5.0 microhms per centimetre cube, and its temperature coefficient of resistance is 0.0051 (0–170°C.). Molybdenum has a resistance of 4.3 microhms per centimetre cube at 25°C. with a temperature coefficient of 0.0050 (0–170°C.).

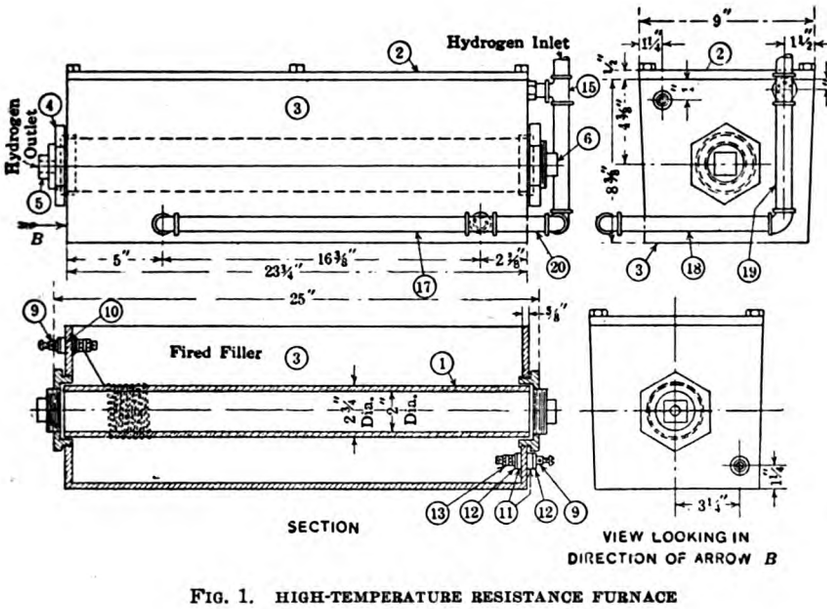

FIG. 1. HIGH-TEMPERATURE RESISTANCE FURNACE

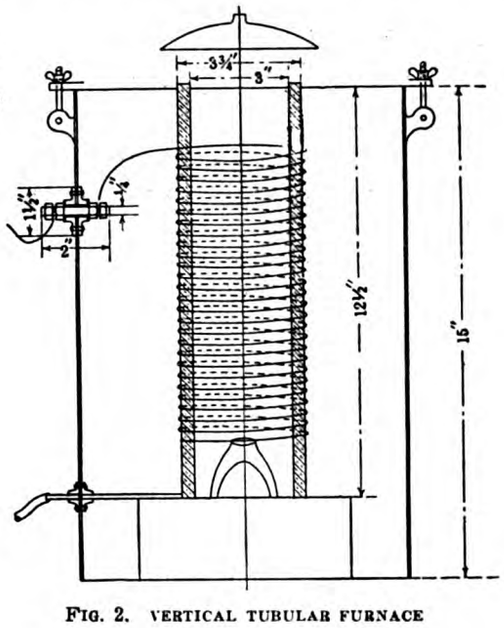

FIG. 2. VERTICAL TUBULAR FURNACE

The horizontal type of furnace in greatest use is shown in Fig. 1. The alundum tube (1) is fitted into the cast-iron box (3) provided with a lid (2) which is bolted on over an asbestos gasket. The flanges (4) are screwed in so as to make a good contact with the ends of the tube (1). Hydrogen is piped into the case through inlets (15–20), and escapes through the alundum tube and the outlet (5). No. 9–13 show details of the current-terminals. With this furnace, temperatures up to 1750°C. are readily obtained, but if a higher temperature is attempted the alundum tube begins to sag badly. Furnaces have been successfully maintained at higher tem-

*Abstract: 'High-Temperature Resistance Furnaces with Ductile Molybdenum or Tungsten Resistors,' presented at New York meeting, A. I. M. E., February 1918.

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peratures, but only with tubes of small diameter for the same thickness of wall. With one of these molybdenum-wound furnaces a temperature of 1700°C. may be attained in about 2 hours, but, for safety, about 3 hours is usually allowed.

It is often necessary to construct furnaces of larger size; these have been equally successful, but not for such extreme temperatures. For maintaining a temperature of 1750 – 1760°C., with a 36-in. alundum tube, 3 in diam. inside, wound with 128 turns of 0.05-in. molybdenum wire, four turns per inch, insulated with 4-in. alumina, this furnace required a total of 5920 watts or 5920÷301.6 = 19.6 watts per square inch of inside heating-surface. Horizontal furnaces of this diameter do not last long at this high temperature, but if the temperature is kept below 1600°C., a long life is possible.

Another useful form is the vertical crucible furnace. This type has been built in many different sizes. The heating tube varies from 1¾ to 6 in. inside diameter. Fig. 2 shows the construction. The alundum tube is 12½ in. long by 3 in. inside diameter, with ¾-in. walls; wound with 26 turns molybdenum wire, 0.067 in. diam., 3 turns per inch, and insulated with alumina, 3¼ in. thick. The total heating area is 84 sq. in., the current used being 31.2 watts per square inch at 1565°C.

A molybdenum resistance wire, after having run at a high temperature for some time, crystallizes so that it loses much of its original ductility and can seldom be unwound without breaking. If it is not too much caked with the fused alumina-packing, it can be loosened and the whole slipped off and put on another tube.

INFLUENCE OF BRINE ON REINFORCED CONCRETE

Reinforced concrete is by far the most popular structural material in use today. It is employed for the foundations of stamp-mills, often for the buildings enclosing them, and for treatment-vats contained therein, while the flume that conveys the water for power is frequently made of this material; but concrete, like everything else, has its limitations. The oldest reinforced concrete structures were built less than 20 years ago, and what the best of them will be like 50 years hence is a matter of pure conjecture. It is known, however, that there are some purposes for which reinforced concrete is wholly unsuited, and particularly is this the case where it is subjected to the action of salt and brines. Sea-water gradually causes the disintegration of cement; although many massive concrete structures have withstood the action of sea-water for many years, and are likely to stand for many years to come. Still, the disintegration is slowly going on, and is generally supposed to be caused, during setting, by the action of the magnesium sulphate of the sea-water on the lime and aluminates of the cement, with the formation of calcium sulpho-aluminate, which crystallizes with a number of molecules of water. Commercially, in fact, outside of the laboratory, it is practically impossible to make a concrete wholly impervious to water, and when the water coming in contact with the concrete carries salts, such as sodium chloride, that have a corrosive action on iron, it conveys them to the reinforcing material, and the latter, instead of being a source of strength, then becomes a source of weakness, for, in corroding, the iron expands, first cracking and ultimately breaking away the surrounding concrete. H. J. M. Creighton* gives an account, illustrated by photographic reproductions, of a number of buildings of reinforced concrete that he has examined in different parts of the United States. In all of these buildings salt or brine was used to a considerable extent, for the curing of foods or for other purposes, and the solutions being spilled on the reinforced concrete floors invariably produced a markedly detrimental effect. In the early stages the under side of these floors developed cracks stained by iron oxides and chlorides. As the injury proceeds, these cracks, which follow the network of reinforcing material, enlarge, and ultimately wedge off portions of the concrete. In some of the worst cases cited the reinforcing material, which originally was ⅛ in. diam. swelled to ¼ in. while the core of iron-wire inside was only 1/25 in. diam. When concrete construction is carried out in winter in cold climates, salt is often added to the mixing-water to prevent freezing. Mr. Creighton examined a quantity of such work and found that, when subject to the influence of moisture, deterioration invariably resulted, but when kept dry no damage could be observed.

From his observations, Mr. Creighton draws the following conclusions: "1. All concrete which is not waterproofed in some way is somewhat porous to water and brine. 2. Brine readily softens the surface of concrete, and, therefore, more easily penetrates to the reinforcement, on which it exerts a disintegrating action that, owing to the attendant expansion, causes it to crack and split and, in some cases, to fall away from the reinforcement. 3. The more porous the concrete the more rapid the disintegration of the reinforcement through the action of brine. 4. Reinforced-concrete floors that come in contact with brine will gradually develop leaks. These will be followed by incrustations of discolored salts on the under side, when, later, iron-stained hair-cracks will develop, running parallel to the reinforcement. As the deterioration progresses, the cracks will widen and, owing to the great expansive force of the accumulating iron oxide, the concrete will be gradually pushed from the corroded reinforcement and ultimately fall."

From these observations it will be evident that where concrete comes in contact with water carrying salts in solution that corrode iron, reinforcement will ultimately be a source of weakness rather than strength. Thus, in flumes that are to carry some of the brackish waters of the West, reinforced concrete is likely to prove less permanent than plain concrete. Mr. Creighton's article raises the question whether it might not be more economical in the end to use some reinforcing material other than iron—monel metal, for instance.

*Journal of the Franklin Institute, November.

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Centrifugal Pumps*

By H. S. BUDD

For many years the centrifugal pump was considered useful only for handling large quantities of water at low heads, and to be uneconomical to operate. The development of the steam-engine and its application to direct-acting steam-pumps kept the centrifugal pump in the background, where it remained almost forgotten for many years. With the introduction of electricity and electric-motor drives, and later on steam-turbines, however, there arose a demand for a pump that could be direct-driven at comparatively high speeds. The centrifugal pump has been improved to meet this requirement.

Centrifugal pumps, as built today, are of two general classes—namely, open and enclosed impeller types, depending on the type of impeller used. Open impellers consist of a number of arms or vanes radiating from a hub in the manner of the ordinary centrifugal blower. The sides of the vanes are usually faced and run close to the walls of the casing on both sides in order to prevent, as far as possible, slip of the liquid being pumped. Open-impeller pumps have been made to show satisfactory results on low-head pumping, especially when delivering large quantities against a head of a few feet; but there is always a large proportion of slip between the impeller and casing, as well as excessive skin-friction and internal disturbance, in this type of pump. These defects become more pronounced as the head is increased. These losses are variable and they prevent high efficiency. The designer cannot predict with accuracy the ultimate performance of the pump. Open-impeller pumps are adapted for low heads when handling liquids containing some solid matter that would tend to clog or hang in the enclosed-impeller types.

Enclosed impellers consist of blades or vanes of suitable curvature radiating from a hub and enclosed by two discs or walls. The liquid to be pumped enters at the centre eye of the impeller around the shaft on either one or both sides, depending on whether it is of the single or double suction type, and passes through the wheel in channels formed by the walls and vanes. Double-suction impellers that are subjected to the same pressure conditions on either side are automatically balanced against thrust along the line of the shaft for ordinary heads. Single-suction impellers are not so completely balanced, and therefore require end-thrust bearings.

As the enclosed impeller handles the liquid being pumped through confined passages or channels of definite form with a limited amount of disturbance and leakage, a capable designer can control accurately the performance of the pump over a broad range of operation. For this reason enclosed impellers are used for all medium and high-head pumping equipment and when high efficiency is desirable.

Except for high heads the single-stage pump is generally used. This pump contains one impeller and can be built for almost any capacity and head within reasonable limits and with efficient results. The larger sizes are more economical, of course, than the smaller. The greater the head for a single impeller, the greater will be the difference in pressure between suction and discharge chambers of the pump. This is accompanied by increased internal slip and leakage and more rapid destruction of the internal parts. This, therefore, is one of the factors that determine the greatest pressure or head allowable per impeller or stage.

For high heads multi-stage or turbine pumps are used, consisting of two or more enclosed impellers on the same shaft and running in the same casing, with passages arranged so as to lead the liquid through the several impellers in succession, each one adding its share of the total pressure desired. By this means pressures of several hundred pounds may be obtained from a single pump, the limit depending on the mechanical limitations of design, strength of materials used, and their resistance to abrasion by the liquid at high velocity.

In multi-stage pumps the liquid discharged at high velocity from all but the last impeller must be abruptly turned through 180° to enter the eye of the succeeding one. Suitable vanes, known as diffusers, are provided to reduce the speed of this water as far as possible and to convert the speed into pressure as soon as the water leaves the impeller, so that it may be conducted into the succeeding impeller with the least disturbance and impact on the walls of the casing.

All multi-stage pumps require some means of maintaining correct alignment of the rotating element with the passages in the casing, and of equalizing any end-trust that may be present. In pumps handling clean fresh water this is best accomplished by means of an internal hydraulic device in which the thrust is carried on a body of water confined by a suitable piston or diaphragm, mounted on the shaft. This device is simple in construction, yet it adjusts itself automatically and promptly to varying load conditions. Being a water bearing with no metal-to-metal contact, it operates with practically no loss of power. Where the liquid pumped carries grit or solid matter that would wear rapidly, the parts of the hydraulic balancing-device, a step-bearing of the Kingsbury or marine-thrust type, external to the casing, should be substituted.

A centrifugal pump should be of substantial construc-

*Abstract of paper read at joint technical session of the Iowa and Illinois Association.

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tion, free from vibration of the rotating elements, with large, well-oiled, and close-fitting bearings, both to ensure continuous operation and to preserve the fine running-clearances within the casing that prevent internal leakage from the spaces of higher to those of lower pressures. The material of which the various parts are made should be suited for the duty to be performed. The general design should permit inspection of the interior and renewal of parts.

The principle of the centrifugal pump is simple. However, to design and build a pump to deliver a given quantity of liquid against a specific head at a fixed speed and at the highest efficiency is a difficult problem. A capable designer can predict within a small proportion of error both the performance and brake horse-power required, not only at the normal operating-point, but also over a range from a condition of free discharge against no head to one of closed discharge and no liquid flowing. The solution of these problems requires knowledge of centrifugal-pump theory, and an analysis of a great amount of data obtained experimentally from pumps of similar characteristics.

The production of a satisfactory pump requires not only a correctly designed impeller, but also a casing of such mold and cross-section that changes in the velocity of the liquid will take place gradually and without shock and disturbance. These requirements necessitate careful and accurate shop-work. It is, therefore, essential that each pump be subjected to performance tests after completion in order that any discrepancies may be detected and properly corrected. Each plant is a problem by itself, and must be treated as such if definite results and highest efficiency are to be realized.

Centrifugal pumps may be driven directly or by belt or gears from electric motors, steam turbines or engines, or other source of power, as best suits the requirements of the particular installation. Direct-connected to steam-turbines they make highly satisfactory steam-operated units. They operate on less steam, and require less lubricating oil than ordinary steam-pumps. They occupy small space. Their advantages in freedom from valves, valve-motion, and rubbing parts are too evident to need further comment.

Motor-driven centrifugal pumps have met with great favor in waterworks service in small towns and villages. When operated with a standpipe or elevated tank they may be arranged to be automatically started and stopped by a pressure-regulator or float-switch. When used on direct-pressure systems the pump or pumps may be run continuously, maintaining the pressure and delivering only such water as is drawn from the mains. In localities where a part of the district supplied is on a higher elevation or some distance away, requiring excess pressure, it is convenient to maintain a domestic pressure at the pumping station suitable for the greatest demand, and to insert a centrifugal pump in the main that supplies the higher pressure. Such an installation is known as a booster pump. It may float on the line continuously, adding a fairly constant net pressure irrespective of the amount drawn from that line. It is often the practice to use a moderate pressure in the water-mains for domestic service and to increase it materially in case of fire. As motor-driven centrifugal pumps are preferably constant-speed machines, and therefore suitable for one pressure only, it is common in cases of this kind to install two or three duplicate pumps designed for domestic service and to obtain increased pressure for fire service by operating two in series.

Boiler-feeding is a service for which the centrifugal pump is suited. The pump is usually driven electrically or by a steam-turbine, whichever is best suited to the particular plant. In operation the motor-driven boiler-feeder is generally allowed to run continuously at full speed, maintaining a fairly constant pressure on the feed-line for a considerable range of capacity. The amount of water fed to the boiler may be controlled by a throttle-valve in the feed-line without danger of creating a dangerous pressure-increase in this line, as the centrifugal pump will not build up a pressure exceeding 15 to 20% above normal pressure, even when the discharge is entirely closed. Turbine-driven boiler-feeders are sometimes operated in this manner, but they are more often equipped with pressure-regulators similar to those used on ordinary steam-pumps, to maintain a constant differential between the steam and the feed-line water pressure, especially where the variation in steam pressure is considerable. Whether driven by electric motors or by turbines the feed of the water to the boiler can be regulated without reference to the pump, and, further, there are no valves or large packings to be maintained, nor is there danger of water-hammer and breakage in cases of loss of suction as with reciprocating pumps.

The efficiency of any centrifugal pump is highest at only one combination of head and capacity for each change in speed. Therefore if a pump be operated against a head or at a speed other than that for which it is designed, the amount of delivery and the power required can be predicted only approximately. The efficiency would be likely to be low, making the installation unsatisfactory for the work it was intended to do, as well as expensive in cost of power for driving.

There are a few parts of the enclosed-impeller type of pump that are subject to the greatest wear—namely, that part of the casing which makes a running-joint with the impeller and the parts of the shaft within the stuffing-boxes and the bearings. If the wearing surfaces are provided with renewable parts that can be replaced at small expense, the main and more costly parts, being protected, will last almost indefinitely, ensuring a low cost of maintenance. Wearing-rings, fixed in the casing around the impeller-inlet, protect the case from wear at this point. A similar pair of rings made of bronze and placed on the impeller protect it from wear. Bronze sleeves on the shaft and passing through the stuffing-boxes protect it from scoring by the packing or from rusting. By supplying the bearings with removable ring-oiled split babbitt-lined shells of the spherically seated type, which may be removed easily when worn and either re-babbitted or

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else replaced by a new set, the alignment of the rotating element will not be disturbed, and the close fit between the impeller and case, so necessary to prevent internal leakage, will be preserved.

Both the total head and the capacity of a centrifugal pump are sensitive to speed-variation; therefore great care must be exercised in determining the speed at which a pump is to operate in order that it may be designed accordingly. This is particularly important when the pump is to be direct-connected to a constant-speed alternating-current motor, where the speed at full load is considerably less than at no load, and where there is no convenient way of altering the speed.

A centrifugal pump cannot raise a liquid to itself from a lower level without first being primed, because it possesses no positive-displacement feature. Both the pump-case and the suction-piping must be filled before starting. Priming may be done either by providing a foot-valve on the lower end of the suction-line and filling the pump and suction-piping from the discharge-line or other source, or by drawing the liquid into the pump through the suction-pipe by exhausting the air from the top of the pump-case. With this latter method, the discharge must be closed by a gate-valve. The foot-valve may be omitted if desired, provided the pump is started while it is primed. The air may be withdrawn from the pump with a suction-pump, steam-injector, or other means of creating sufficient vacuum to permit the pump-case to be filled.

Once in operation, a centrifugal pump will handle water or other liquid of the same specific gravity and character at ordinary temperatures against as great a suction-lift as a reciprocating pump—namely, about 26 ft. at or near sea-level, provided the suction-piping and pump are free of air and air-leaks. Because of the difficulty sometimes encountered in maintaining air-tight suction-glands and piping, 18 ft. is usually considered the maximum commercial suction-lift. Even less is advisable whenever possible. The limit of suction-lift decreases with the rise in temperature of the liquid on account of the increased vapor-tension. No suction-lift should be attempted when the water has a temperature exceeding 150° F. Instead the pump should be placed so that the water will flow to it by gravity. When handling water at or near the boiling-point, as in boiler-feeding, the water should flow to the pump under a head from 6 ft. to 10 ft. The suction-piping should be as direct as possible and of large diameter to eliminate the formation of vapor.

The intake-pipe should be as short and direct as possible, with tight joints. The intake-pipe and foot-valve are usually made at least one size larger than the pump-inlet in order to reduce friction, which, of course, adds to the suction-lift. As the basic principles of the centrifugal pump require the liquid to be handled at high velocity, the suction and discharge openings are smaller than is usual in reciprocating pumps of equal capacity. The sizes of both the intake and discharge pipe-lines should be determined from the amount of friction in the required length.

Centrifugal-pump installations are usually provided with a gate-valve in the discharge to shut the pump from the line when not in use, or when open for inspection.

There is nothing in a centrifugal pump to hinder the liquid flowing backward through it from the discharge-line, when not in operation. Consequently, in case of a sudden stoppage of the power, the impeller, acting as a water-turbine, may be revolved backward at a speed dangerous to both the pump and the prime-mover. A foot-valve on the intake pipe will prevent this occurrence, or, if this is not provided, a check-valve should be placed in the discharge. Where the operating pressure is great and a foot-valve is employed there should also be a check-valve in the discharge to reduce the shock on the pump-case when the foot-valve seats. The check-valve should be provided with a by-pass in order to prime the pump in case the foot-valve should leak.

Suction and discharge pipe-lines should be free from high spots or loops forming pockets in which entrained air may accumulate, as the air-bubbles thus formed will resist the movement of the liquid. In the case of the suction-pipe they are likely to enter the pump in such quantity as to cause entire loss of suction.

COST OF CONSTRUCTION OF EIGHT-INCH PIPE-LINE

The following is a summary of the cost of laying 1500 ft. of 8-in. cast-iron water-pipe at Modesto, California. The pipe was laid in August 1917 to connect a new factory with the city system:

		Total cost	Cost per foot
Pipe		$2,025.30	$1.352
Tees, ells, etc.	$176.15		
Four 8-in. gate-valves	143.01		
One 4-in. gate-valve	11.97		
Total specials		331.13	0.221
108 lb. jute packing		13.50	0.009
200 lb. lead		220.00	0.147
Labor		481.90	0.321
Miscellaneous expense		17.22	0.011
		$3,089.05	$2.06

An 8-in. meter was placed on this line, costing $645 for the meter alone. The cost of setting was $301.70, distributed as follows:

Brick and cement for manhole	$37.50
8-in. offset and flanged tees	53.78
Pattern for 8-in. offset	14.40
Frame and cover for meter	100.92
Pattern for frame and cover	28.35
Labor	43.50
Machine-work on specials	15.65
Miscellaneous expense	7.60
	$301.70

In addition, a fire-hydrant was placed on the line. The cost of the hydrant was $37, and of labor setting the hydrant $9, making the total cost $46, and the total cost of the line $4081.75. Work was done by city forces.

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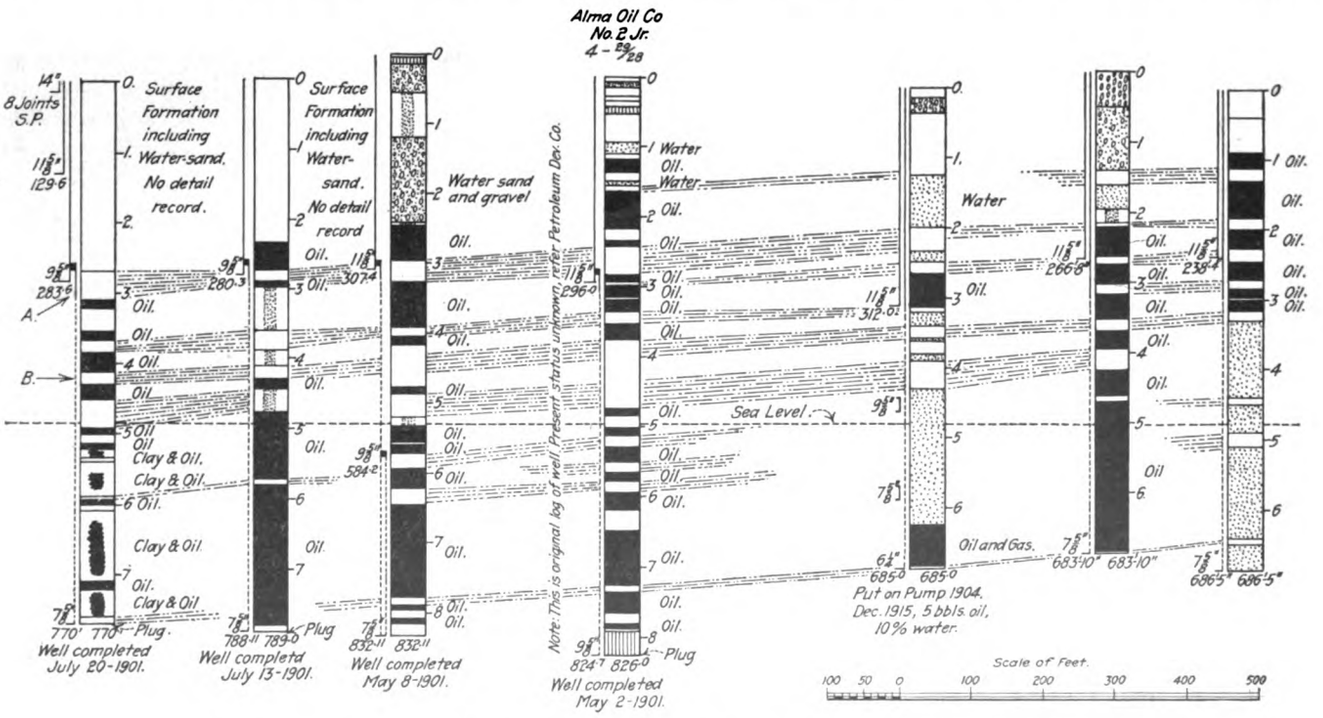
Reduction of Water-Infiltration in Oil-Wells

By R. P. McLAUGHLIN

The value and necessity of high-class technical work in the development of oil lands has been demonstrated by the California State Mining Bureau during the past two years. The law in effect since 1915 gives the Bureau authority to make investigations of underground conditions at oil-wells, and to enforce its decisions. Provision is also made in the statute that the officials in charge of the work shall be engineers or geologists experienced in the development and production of petroleum. The authors of the law insisted on this latter provision as being a prime necessity upon which all specifications, inspections, and penal actions must rest. There was considerable skepticism as to the value of the so-called 'theoretical' work, but repeated demonstrations have convinced open-minded observers that the natural laws of physics and geology apply to oil deposits and that a recognition of these laws is advisable.

For the past fifteen years the Kern River oilfield has commonly been considered as a difficult field of operation. Wells were frequently abandoned as unprofitable on account of the large amount of water that was produced to the exclusion of oil. When wells were not abandoned, expensive machinery, such as air-compressors, had to be employed for lifting the water. Systematic efforts were not made to prevent the water from entering the wells, and consequently the profits from the field have been reduced. Properties of the Associated Oil Co., the Atchison, Topeka & Santa Fe Railway Co., and the Alma Oil Co., in section 4, T. 29 S., R. 28 E., M. D. B. and M., had for many years been affected by water. Several expensive compressor-plants were operated continuously, at at cost of about $500 per month, besides consuming about 100 bbl. of oil per day for fuel. The three companies voluntarily submitted their problem to the State Mining Bureau, and two members of the engineering staff, R. N. Ferguson and G. McGregor, were assigned to make the investigation. Considerable time was devoted to gathering all available statements as to the past and present condition of the various wells. In many cases the information was fragmentary, and the opinions of interested parties were flatly contradictory. Detailed cross-sections were drawn to graphically present this information, both geological and mechanical, as to the various wells. A complete report was furnished to the interested parties, setting forth all the evidence and giving the conclusions of the investigators. Definite recommendations for repair work at certain wells were made. The conclusions were that the water came from two main sources, namely, both from below the productive oil-measures and from above them. The report stated that the 'bottom' water was giving the most trouble, and that it was entering the oil-sands through a few wells which had been drilled too deep. It also stated that 'top' water was also giving trouble, and that this was because



CROSS-SECTION SHOWING LOGS OF SOME OF THE AFFECTED WELLS

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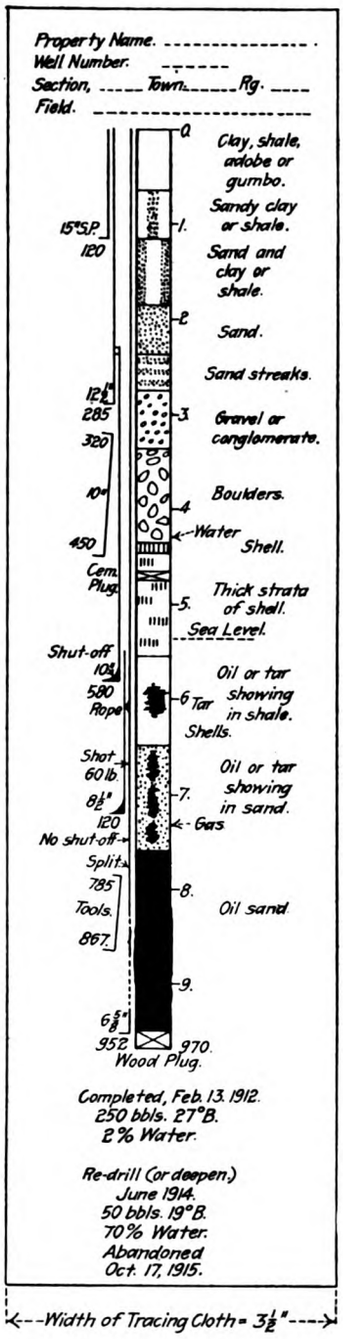

Well Logs

Formations as shown on typical drawing; condition and color of same by word (abbreviated.)
Cement as shown on 10-in. and 8½-in. casings.
Formation shut-off as on 12½-in. and S.P. casings.
Perforations as on 6⅝-in. casing.
Adapter, as shown between 10-in and 12½-in casings.
Packer, as shown between 8½"-in. and 6⅝-in. casings, noting the kind (rope or mechanical.)
Casing cut and pulled, as on 8½-in. and 10-in. casings.
Casing or tools sidetracked, as shown at left.
Casing shot, collapsed, split, or otherwise altered, should be noted on left margin, also any information as to success or failure of shut-off.
All special geologic features, such as gas, tar, water, fossils, and formations, and their colors, should be noted to the right of the log.
The kind of plugs, (cement, wood, or other) must be noted, as shown at left, and bottom.

STANDARD FORM FOR OIL-WELL LOGS USED BY CALIFORNIA STATE MINING BUREAU

no uniform plan for its exclusion had been followed when the wells were drilled. It was recommended that a campaign of repair be followed, commencing with the plugging of the bottom of two wells, which were probably too deep and therefore causing the main trouble. It was pointed out that if this first step failed to remedy conditions, work at other wells would be required in order to control the 'top' water.

The owners of the two deep wells commenced work as recommended. One of the wells (Alma Jr. No. 2) has been pumped by compressed air for a number of years. It produced about 12,000 bbl. of water per day, with no oil. As soon as repairs began at this well, the air-lines had to be removed. The water-level rose immediately in surrounding wells, which thereupon ceased to produce oil. This made it necessary that the proposed repairs should be made as rapidly as possible. To expedite matters, J. E. Beard, president of the Alma Oil Co., arranged that the State Oil and Gas Supervisor should assume the responsibility of choosing a crew of workmen and directing the work. A crew from the adjoining

STREAM OF WATER PUMPED FROM ONE OF THE AFFECTED WELLS BEFORE REMEDIAL WORK WAS DONE

Santa Fe property was engaged, and with the co-operation of D. T. Saine, superintendent for the latter concern, repairs proceeded successfully. It is of particular importance to note that several years ago a similar co-operative agreement between the companies had been made, but the efforts to repair the well were unsuccessful at that time.

No new mechanical methods were adopted by the State Mining Bureau in repairing the well, but it was impressed upon all interested parties that the job was difficult and would not be abandoned, no matter how slow the progress might be. It was recognized that the upward flow of water through about 100 ft. of loose unconsolidated sand could not be stopped until a plug was placed below the sand and in the impervious clay-stratum overlying the water-bearing sand. Such conditions held out no promise of speedy work. The old perforated casing was removed from the well and unperforated 7⅝-in. casing was inserted until it was stopped by the heaving and caving sand at a depth of 702 ft. The casing was carried through the loose sand to a depth of 789 ft. by introducing sufficient clay to fill the interstices of the sand and thus prevent further caving of

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the sides of the hole. This took about four months and required 1000 cu. yd. of clay. The casing could not be carried deeper than 789 ft., but continued use of mud permitted the hole to be cleared to a depth of 886 ft., proving that the original log shown in the cross-section was in error to the extent of 60 ft. This required 100 cu. yd. of clay in addition to the amount already used. The clay was shoveled into the top of the casing and a steady stream of water was also kept running into the well. The tools were kept swinging at the bottom of the open hole, mixing the mud and assisting the water to carry it into the loose sand. The casing had to be raised and lowered to keep it free. A system of mixing the mud at the surface and pumping it into the hole would have been quicker, but the necessary equipment was not available.

Within a week after mud was started into the well, it began to show in the fluid pumped from surrounding wells, as much as a quarter of a mile away, both up and down the dip of the strata. As fast as neighboring wells showed mud, they were shut-down, so that the mud would not be drawn away unnecessarily from the well under rapair. The well was plugged between depths of 886 and 702 ft. The plugging was done by stages from the bottom. The general plan was to 'shoot' away the casing in impervious clay streaks and to place solid cement plugs. Between the clay streaks the casing was not 'shot' ordinarily. Instead a filling of clay, cobbles, and rope was tamped into the hole. Each cement plug required from 10 to 15 sacks of cement. Five 'shots' of 30 to 50 lb. of 60% dynamite each were exploded. A heaving-plug was set in the casing at a depth of 702 ft., and the casing was perforated between 684 and 702 feet.

The total cost of the work was as follows:

Labor (March 1 to September 17)	$4,444.48
Lumber	180.05
Material, miscellaneous	562.40
General expense	231.20
Hauling clay	2,499.14
	$7,917.27

The condition of wells in the vicinity, both before and since repairs, is shown by the following table:

	Before repairs		After repairs	
	Oil	Water	Oil	Water
No.	bbl.	bbl.	bbl.	bbl.
Alma Jr.				
1	trace	150	7	00
2	00	12,000	trace	100
5	trace	200	10	trace
11	"	250	7	40
12	"	200	10	25
1	3	32	4	10
Petroleum Development Co. (Santa Fe)				
2	00	1,440	(not yet rigged for pumping)	
6	5	250	4	20
10	5	400	5	10
14	5	5	5	10
18	7	1,000	7	25
Total	25	15,927	59	240

The saving in operating expense and fuel at the compressor-plants, plus the increased production from affected wells, amounts to about $150 per day, which is a yearly profit of nearly 700% on the expenditure for repairs. The profit would have been much greater had the well been repaired at first before the compressor-plants were built. It may surprise the average reader, holding the common belief that large oil companies are highly efficient, to learn that comparatively few concerns take full advantage of technical knowledge. The State Mining Bureau has, during the past year, called the attention of all concerns having an annual oil production of more than a million barrels to the advantage and economy of thoroughly organized technical staffs authorized to direct their development work. A gratifying improvement has been noted, but some companies do not yet realize the importance of this matter. The public has always been concerned in the protection of our oil-fields, and at present the war-time needs make it obligatory that the utmost efforts toward economy of labor and material be exerted. The next annual report of the State Oil and Gas Supervisor will therefore classify all the large producers with reference to their technical organization. The law makes it mandatory for the State Mining Bureau to approve specifications and inspect all work at new wells, and it is therefore impossible immediately to investigate and solve the many old problems similar to the one herein described. There remains in the oil business a broad field of usefulness for competent engineers engaged in private practice or in the regular employ of oil companies.

WATER TRANSPORTATION IN THE UNITED STATES

According to a preliminary report issued by the U. S. Bureau of the Census, American-owned merchant vessels of five tons net register or over, of all classes, operating during the year 1916 on the coast or inland waters of the United States, including Alaska, or between ports of the United States and foreign countries, numbered 37,894 and had a total gross tonnage of 12,250,000. Gross tonnage is calculated by dividing entire internal capacity, in cubic feet, by 100. The geographical distribution of this gross tonnage was as follows: Atlantic Coast and Gulf of Mexico, 6,509,000; Mississippi river and its tributaries, 1,621,000; Pacific Coast, including Alaska, 1,186,000; Great Lakes and St. Lawrence river, 2,738,000; canals and other inland waters, 196,000. The distribution according to method of propulsion was: Steam and other power, 6,098,000; sail, 1,089,000; unrigged, 5,063,000.

The increase in number of vessels as compared with 1906 was only 1½%, and the gross tonnage shows a decrease amounting to 5%. This is caused by the marked reduction in number and tonnage of sailing vessels and in tonnage of unrigged craft. The former show a decrease in number from 7131 to 2979, or 58%, and in gross tonnage from 1,704,000 to 1,089,000, or 36%.

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Spontaneous Combustion*

By NILES SEARLS†

When certain substances that can combine chemically are brought together a certain amount of heat is generated. If this heat is not allowed to escape, the resulting increase of temperature stimulates the chemical action, producing more heat until the point of ignition, either of one of the substances or of some exposed inflammable material, is reached, and combustion follows. To produce this result certain conditions must exist. We must have a substance that is oxidized readily, a comparatively large surface must be exposed to the air, the escape of the heat generated must be prevented, and, lastly, some material having a comparatively low point of ignition must be present.

All of these conditions are present when vegetal fibre, such as rags or waste, is saturated with linseed oil and rolled in a compact mass or piled in sufficient quantity to press the material fairly close together. We have, in such a combination, the most readily oxidized of the vegetal oils with a large surface exposed to the action of the oxygen of the air, also, the presence of the fibre, which has a low point of ignition, to act as tinder. The surrounding temperature affects the rapidity with which the action takes place and actual fire results. A pile of oily waste might be comparatively safe when exposed to zero temperature at Summit, while a similar pile might quickly burst into flames if situated under an iron roof in Yuma in the middle of summer. The greatest danger is caused by the presence of some of the vegetal or animal oils. These oils vary in their ability to combine with oxygen. The amount of iodine absorbed by a given quantity of the oil gives a fair measure of the danger attached to that particular oil.

By this test it appears that the vegetal oils are the most dangerous, linseed coming first, with cottonseed and nut oils following. Animal oils, when pure, are less dangerous; but when impure, and particularly when rancid, they are fully as dangerous as the vegetal oils. Mineral oils, when impure or adulterated with animal or vegetal oils or impregnated with sulphur or iron sulphides, are dangerous. For our purpose, therefore, oily or greasy waste, rags, or vegetal fibre should be considered as a possible source of danger and treated accordingly.

With this general understanding of the cause of spontaneous combustion, we can see that the means of prevention consists in good order and cleanliness or what is ordinarily called 'good housekeeping conditions.' Every pile of refuse and waste material should be considered as a possible source of danger. As time is a necessary element in spontaneous combustion, the prompt removal or destruction of such material will remove the danger. Oily or greasy overalls or clothing if hung in a well-ventilated locker or in the open will be free from danger, but packed in the bottom of a locker or in some obscure corner, may cause a bad fire. Prevent leakage and waste of oils and keep fibrous material away from contact with oils or grease. When it is necessary to bring these materials in contact, as in cleaning and wiping operations, be sure and keep such oily materials in safety-cans, and in small quantities. Remove daily to places where fire would cause no trouble.

It cost this company over $20,000 to find that there was danger in piling baled sacks in a warehouse where leaky barrels of linseed oil had previously been stored and where this oil had not been entirely removed from the floor before the sacks were piled. In general, the storage of sacks, waste, or similar materials in high piles should be avoided. When possible, openings should be left in or through such storage piles to allow the escape of any heat which may be generated. Remove the useless fine dust from coal and charcoal bins and be careful to prevent such material from becoming wet, as moisture aids the chemical action and increases the heating. In this, as with many other fire-causes, order and cleanliness spell safety.

*From the Southern Pacific 'Bulletin.'

†General fire inspector, Southern Pacific Co., San Francisco.

Several months ago it was arranged that the funds that had been contributed by the American Red Cross for the relief of the victims of the floods in north China should be utilized principally in the construction of a road between Peking and Szechuan, thus providing employment for the flood victims. A report on the projected road was made by a firm of engineers. The engineers have divided the road into three divisions with Tungchow and Yangtsun as the dividing points. The distance from Peking to Tungchow is 14 miles. This is the division that is being built first; in fact, it is not yet certain whether the remaining two divisions will be built for some years to come. The road will start from Peking and follow the old stone-slab road that was built several hundred years ago, presumably to transport freight from Tungchow to Peking. The stone road ends near the centre of the city of Tungchow, and a new road will have to be built to the railway station. The total cost is estimated at $87,256 between Peking and Tungchow. As far as possible the old granite slabs will be broken and used for the construction of a new macadam road 15 ft. wide and 7 in. thick, with 5 ft. of stone blocks and 5 ft. of earth on each side.

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V-Notch Wear Measurement*

By D. ROBERT YARNELL and G. A. BINZ

*Weirs of various types are familiar to hydraulic engineers, and employed by them for the measurement of the flow of streams and of large volumes of flowing water. Fig. 2 shows a comparison of the flow-curves obtained when using various types of weirs. The rectangular form is most popular for large flows at a rather constant rate. It has been found less suitable for boiler-feed measurements, because different co-efficients have to be used for different ratios of width to height, and because the rectangular notch furnishes small motive-power at low rates of flow. The V-notch obviates both these objections. Its accuracy is essentially the same at all rates of flow. The curve also shows that, at low rates of flow, the head increases rapidly for small increments in volume. The V-notch is therefore an ideal weir for boiler-room measurements, and has become universally adopted for this purpose. Measurements of flow by means of the V-notch are based upon the well-known formula: $Q = KXH^5$ in which

Q = quantity flowing in a unit of time.

K = a constant.

H = height in inches of liquid flowing through weir.

The flow, therefore, is not directly proportional to the head, and some compensating device must be embodied in the recording-mechanism, if, as is desirable, the recording member shall travel equal distances on the chart for equal increments of flow. Various methods have been proposed with this in view, and a few of the more important ones will be briefly described. These methods may be divided into the following groups:

1. Instruments which use a plain float, and employ some intermediate method for correcting the travel of the pen on the recording-chart.

2. Instruments in which the compensation is provided in the shape of the weir, or where a float of special construction is used to secure equal rise for equal increments in flow.

3. Instruments operated electrically.

4. Instruments which weigh the liquid.

Commencing with group No. 1, probably the forerunner of the best-known V-notch meters was that designed by James A. Gardner and built by the firm of Glenfield & Kennedy, Ltd., of Kilmarnock, Scotland. The idea underlying the construction of this meter is as follows: The length of a pendulum H, which controls the escapement of the integrating device, is made to vary as the 5/2 power of the head of liquid in the notch. This is accomplished by causing the suspension-carriage E of the pendulum to ride on a cam D, made to rotate as the float rises and falls. The device is so adjusted that there is no movement of the integrator when the float is at zero. As the float rises, the pendulum is shortened and the clock-escapement, which it controls, runs more rapidly. No chart-record is provided. Great delicacy is probably the principal disadvantage of this ingenious design. Next is the Lea meter. With this a cam is interposed between the float and the recording-chart. The cam is in the form of a drum carrying a screw-thread with variable pitch so calculated that the pen will be caused to travel equal distances on the chart for equal increments of flow. Another meter which uses this method of correction, but employs a spiral groove cut upon the surface of a flat disk, is the Cochrane (Fig. 4). The float is suspended from the cord S wound around drum B and counterbalanced by weight W. The cam-disc is mounted on the same shaft B and rotated when the float rises or falls, thus moving the carriage D to which the recording pen and integrator are attached.

Another group comprises those in which the correction, necessitated by the fact that the quantity of water flowing through a V-notch is as the 5/2 power of the head, is made directly by shaping the weir or the float employed. One of the earliest methods of this kind is the weir designed by Wilfred Yorke, an Englishman (Fig. 5). This is so designed that the area varies as the square root of the height, and therefore the quantity of water flowing varies directly as the head. It has been found in practice that this weir cannot be shaped in accordance with calculated curves, as the varying effects of contraction and other disturbing factors have to be taken into consideration. It is therefore made in accordance with empirical determinations. The same principle is employed in a weir formerly manufactured by the Kennicott Co. (Fig. 6), where the water falls through a specially shaped slot, and for equal divisions of head A, B, C, D, and so on, the area added for the passage of water to the interior of the weir grows progressively smaller as the head increases. Both of these were found in practice to show considerable inaccuracy at low flows. Of meters in which the compensation to the chart-reading is obtained by employing a specially shaped float, probably the earliest was invented by J. W. Ledoux and built by the Simplex Valve & Meter Co. (Fig. 7). In this meter the buoyancy of the float is successively changed by causing the lower conical portion of the float to displace a varying quantity of mercury contained in M. In this way the effective weight of the compound float-system is successively decreased in such manner that the float will travel equal distances for equal increments

*Abstract: Proceedings Engineers' Club of Philadelphia from paper read before the Philadelphia Section of A. S. M. E., April 1917.

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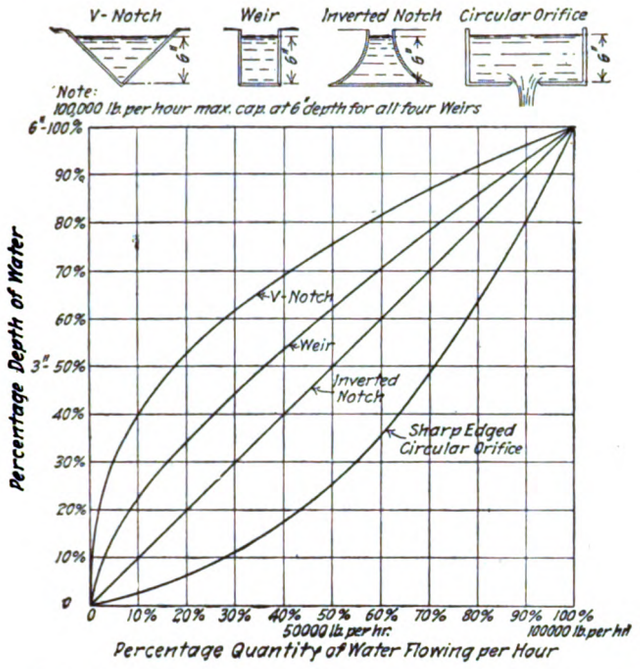

FIG. 1. CURVES REPRESENTING DIFFERENT WEIRS

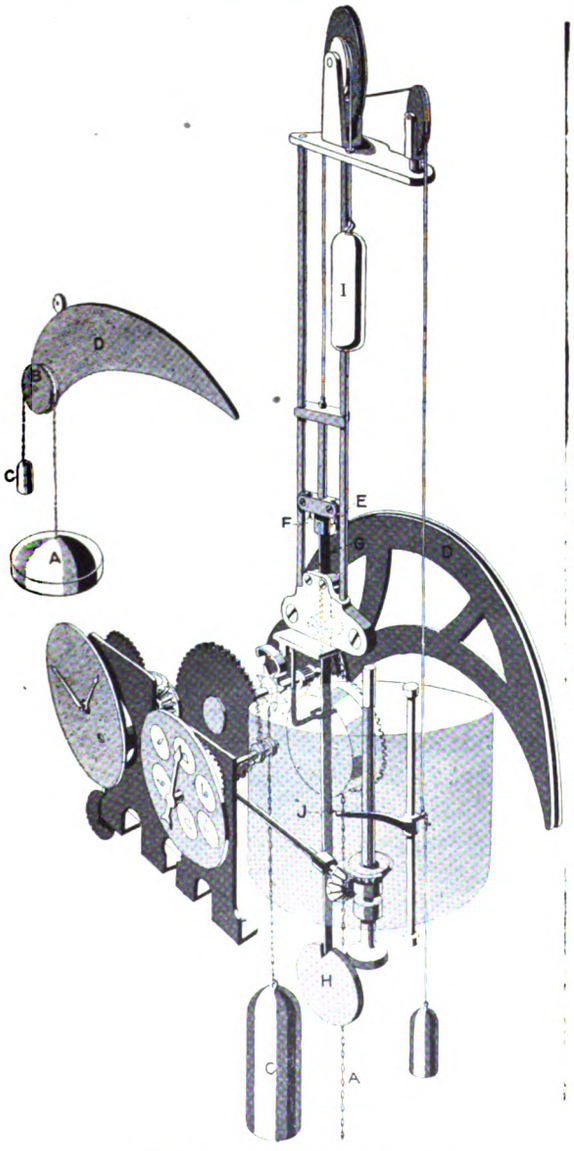

FIG. 2. THE GARDNER METER

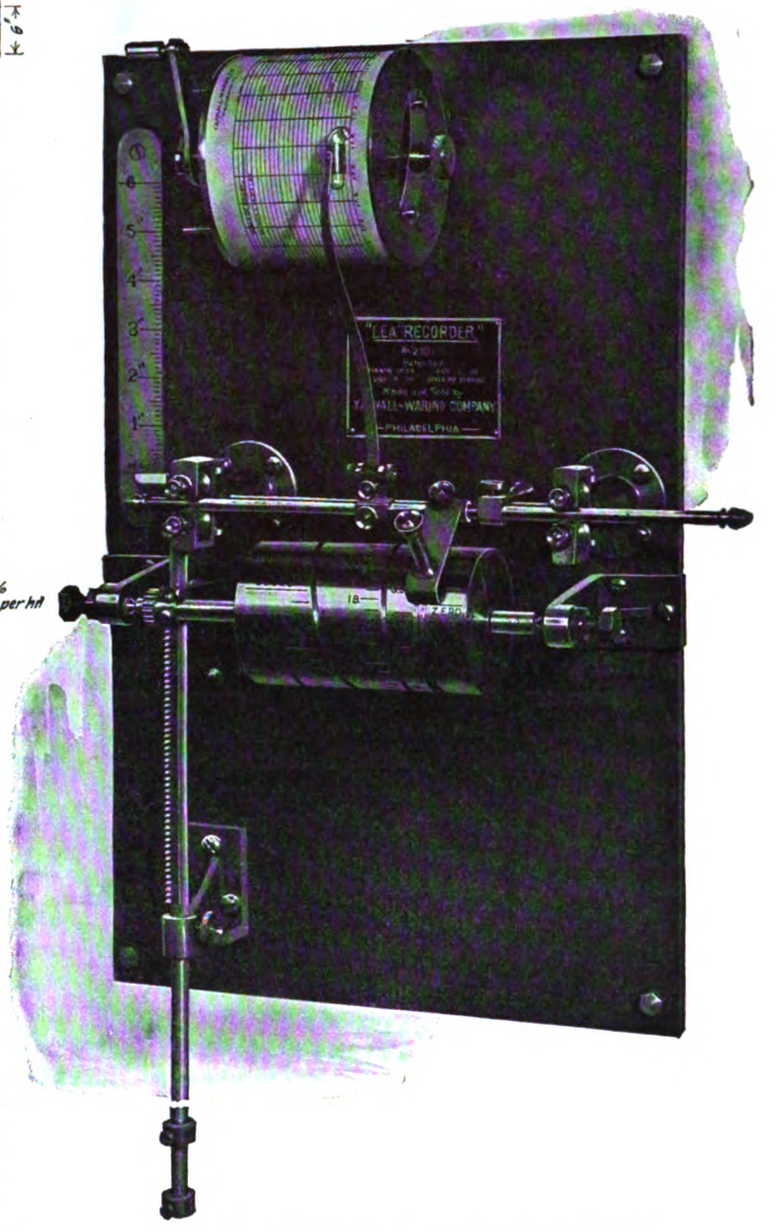

FIG. 3. RECORDING MECHANISM OF LEA METER

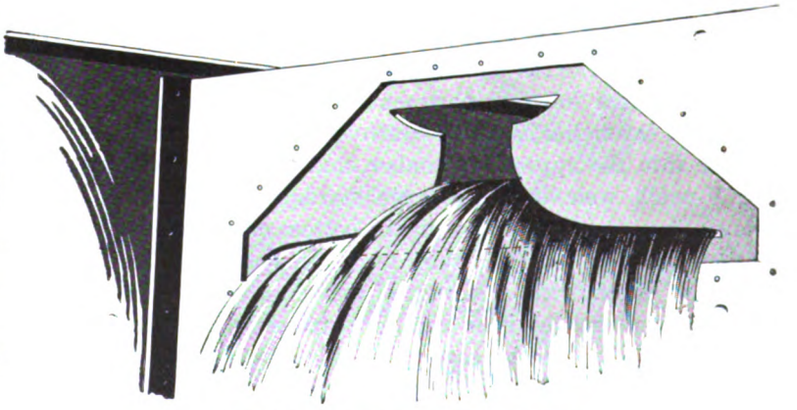

FIG. 5. THE YORKE INVERTED WEIR

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in flow. Another form employing this principle of changing buoyance is found in the ingenious design by E. G. Bailey, of Boston. Here two displacement-bodies are used, suspended on opposite ends of a scale-beam that is pivoted on knife-edges. The two bodies are so adjusted that they rest on the surface of the water when no water is flowing through the notch. In this position both bodies are of equal area, displace equal volumes of water, and are therefore balanced. The cross-section of one of the bodies increases upward, whereas that of the other diminishes. As the water rises they therefore displace different volumes of water, and one will sink lower than the other before equilibrium is restored. A turning motion of the scale-beam results, which is transmitted to the recording chart. By shaping the contours of the two bodies, their motions are made to conform exactly with the 5/2-power curve of flow.

Of electrically-operated devices, only one has come under my notice; namely, that proposed in 1914 by Rateau, the inventor of the Rateau turbine. The head, in this case, is measured by the difference in level in a mercury U-tube. The leg in which exists the lower level carries a resistance-element, such as a high-resistance wire wound upon an insulator. This element is made part of an electric circuit in which is included a special differential millivolt-meter. As the mercury rises and falls in the leg of the U-tube, more or less of the resistance is cut out of the circuit, and the amount of current flowing may be caused to vary in accordance with the curve of the rate-of-flow.

The last group of meters comprises those that weigh the water as it flows through the weir. It must be conceded that, so far as the operation of a power-plant is concerned, this has much to recommend it, seeing that it gives its information directly in pounds of water. It will be seen, however, that the task of weighing the flowing water is difficult, necessitating a complicated form of apparatus. A typical example is the meter made by the Hoppes Manufacturing Co. (Fig. 8). This consists of a weighing vessel *W*, of special shape, suspended on a spring-scale. It has flexible connections to the weir-chamber *A* and to atmosphere *B*, and is so arranged that the scale is balanced at zero when no water is flowing through the notch. As the water rises in the weir, it also flows into the weighing-vessel and, owing to the special shape of the latter, pulls on the scale in exact proportion to the rate of flow.

In the Lea meter, as built today, the water to be measured enters the inlet-compartment of the steel or cast-iron tank, through a balanced control-valve, passes under a baffle into the approach-chamber, and thence through the V-notch weir into the large storage-compartment below. A pipe connecting with the bottom or end of the storage-chamber takes the water to the feed-pump. This design of tank, with a storage-chamber extending the full length under the inlet and approach-compartments, is patented. It possesses several notable advantages. It provides an exceptionally large volume of water for pump-storage, a long approach to the weir insuring accurate measurements, and, moreover, by regulating the inlet with a float or bucket balanced upon this large pool, it is possible to secure easily readable charts. One corner of the inlet-compartment is partitioned off to form a still-chamber for the float. This chamber is connected with the weir-compartment by a small opening protected by a strainer. A very large and powerful seamless copper float rides upon the surface of the water in this still-chamber, and conveys its motions to the recording instrument mounted on the tank. In order to secure equal divisions on the chart, the recording-pen is not attached directly to the end of the float-rod, but an ingenious compensating mechanism is interposed between these members. As a check upon both the recording and the integrating mechanisms, a scale is fitted into each instrument, on which a pointer, attached to the end of the float-rod, indicates the height in inches of the water flowing through the notch at any time. By inserting this figure in the formula heretofore given, the accuracy of the instrument may be readily checked at any time while in normal operation. One American development of metering feed-water with the V-notch deserves brief mention. This is a metering heater, consisting in the standard Webster open feed-water heater which is combined with the Lea meter, the water, after being heated by the exhaust-steam, passing through an outside connection and the usual balanced control-valve, to the metering section. A considerable saving in floor-space and a conservation of heat-units result from this combination.

A Lea recorder was installed in the hydraulic laboratory of the University of Pennsylvania, directly connected to the cylindrical steel pressure-tank. This tank was over 5½ ft. diam., and 37 ft. high. A stand-pipe with numerous overflows was provided, by means of which the head on the discharge-pipe could be varied at will by 2-ft. intervals. The meter discharged into an open flume, which carried the water to the large weighing-tanks on the floor below. These tanks were of steel, and had a capacity of about 15,000 lb. each. They were supported on accurate scales, sensitive to a weight of 5 lb. An efficient system of hydraulic valves allowed instant change from one tank to the other. The tanks could be emptied in 35 seconds. A hook-gauge was attached to the weir-chamber of the meter, and independent readings were taken every five minutes. The temperature was recorded on the same chart as the water by means of a recording thermometer fixed in the meter-case and checked at frequent intervals by a mercury thermometer. All readings were double-checked. A varying flow was obtained from practically zero to a considerable overload, thus reproducing power-plant conditions. The results are summarized below:

Total water weighed, pounds	154,559
Area of chart by planimeter	4.23
Scale of chart	36,312
Total water by chart, pounds	153,599.76
Error of chart-record against water weighed, per cent	0.62
Total water by integrator-reading, pounds	156,500
Total error of integrator, per cent	+1.256

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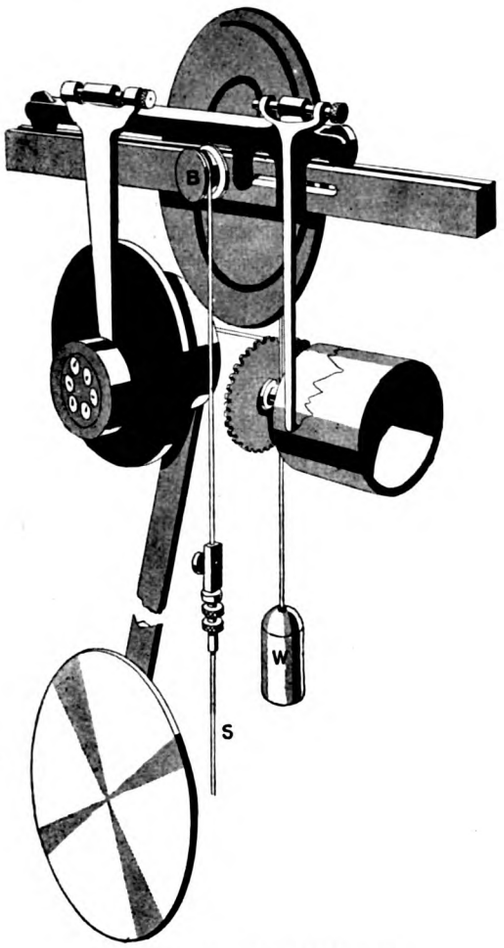

FIG. 4. COCHRANE RECORDER

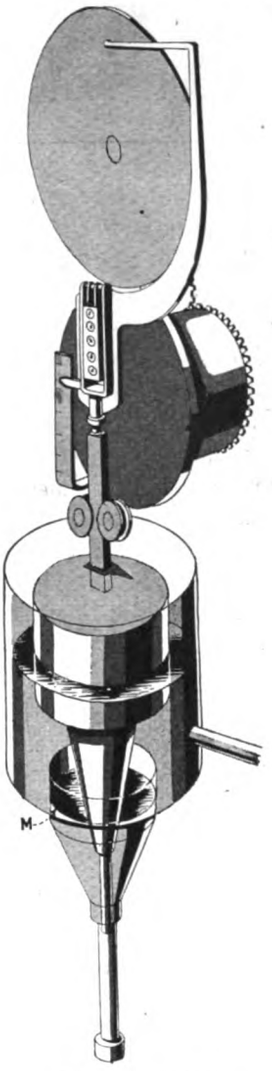

FIG. 7. SIMPLEX RECORDER

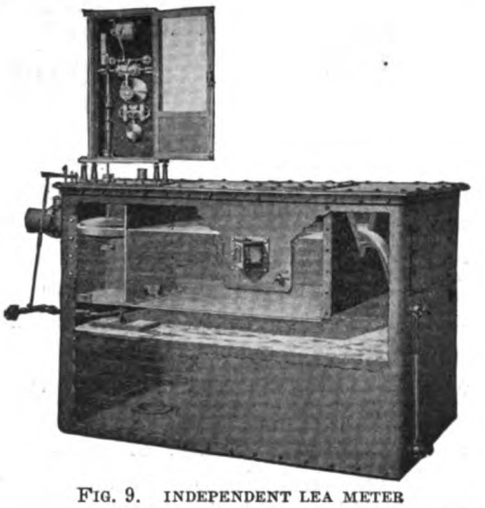

FIG. 9. INDEPENDENT LEA METER

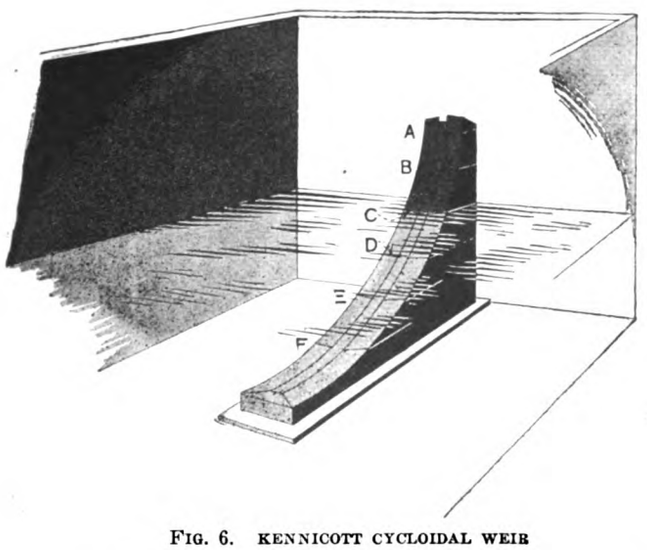

FIG. 6. KENNICOTT CYCLOIDAL WEIR

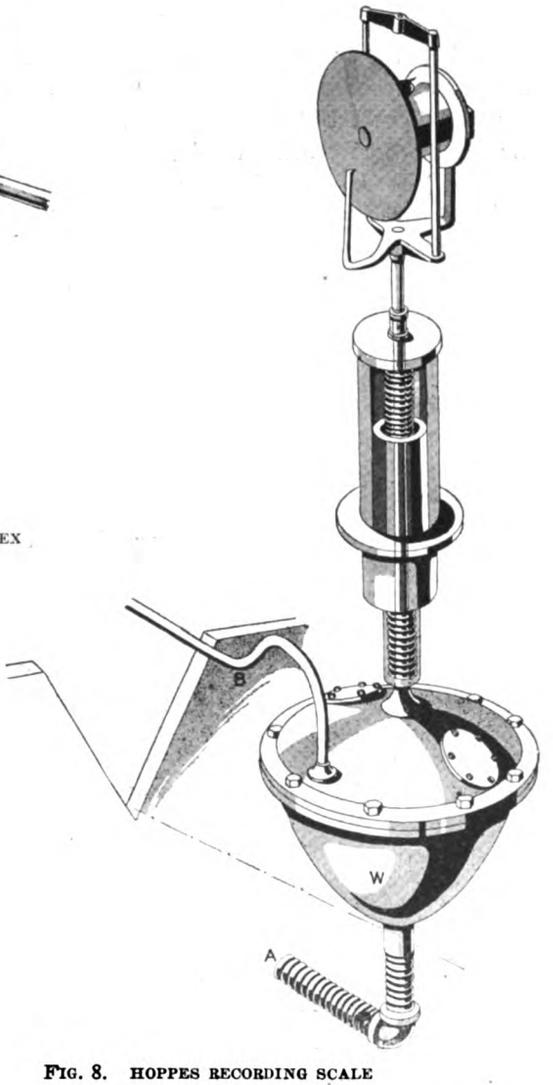

FIG. 8. HOPPES RECORDING SCALE

As pointed out by J. W. Ledoux, it is not generally realized, even today, that the measurement of water flowing through a V-notch is an exceedingly difficult problem. While there are a number of practical, and reasonably accurate, meters available in the market, all of them are capable of improvement. The results of the test given above show a high degree of accuracy. It should be noted that such closely correct measurement might not be obtained when the meter was running at a constant rate within 1% of the maximum flow.

Tractors owned by the British government and used for plowing in various parts of England numbered 1660 in December 1917.

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Bank Credit and Bond Issues

There is something so plausible and insidious about the idea of financing the War by having the banks create new credit that the stern alternative of cutting down the use of credit for other purposes, and of curtailing all business but that which supports the War, has a poor chance of popular favor beside it. What is the objection to a pyramid of credit, based upon Government bonds, and consisting, first, of individual credit, second, of member-bank credit, and, finally, of reserve-bank credit, all backed by the taxing power and the power to issue money? What can be better than such a combination as this? Why not finance the War in this way?

The answer is that this pyramid of credit cannot add one day's work to the industrial resources of the country. The entire programme upon which the Government is proposing to spend about $20,000,000,000 this year is all a matter of day's work. In times of peace the labor of the country is employed in private operations. The production consists in part of necessaries for immediate consumption, in part of luxuries, and in part of additions to the productive equipment. Now comes the War, and the Government wants to take over a great portion of the working force, and also asks the people to turn into the Treasury money enough to pay it. The rational way of complying with this request would seem to be, first, to cut out the production of luxuries or non-essentials; second, to cut down the additions to permanent improvements and equipment, restricting them to such only as will aid in carrying on the War and the essential industries; third, to keep enough people employed upon necessaries to support the country and the army, and to put all the others on war work; fourth, to turn into the Treasury, through taxes and loans, the money which was previously paid to these people now released from private service to war work. Since we are no longer expending the money in the old way we can let the Government have the use of it. The account balances. The country has simply diverted purchasing power from one class of work to another.

The other way of meeting the Government's appeal for help is to say, as considerately as possible, and with all possible assurance of patriotism, that we are sure that, if allowed to continue our industries and occupations as usual, we will be able to do a great deal more for the Government than we possibly can if we are interfered with; therefore, we offer to co-operate in getting up this pyramid of credit, and challenge the world to show wherein this credit is defective or insufficient. We, as individuals, will give our notes to our bankers, the latter will lend us the credit with which to buy Government bonds, and we will deposit the bonds with our notes as collateral security; the bankers can re-discount these notes at the Federal reserve banks, and thus recoup themselves for the advances they have made; and, finally, the Federal reserve banks, on the strength of the Government bonds in their possession, and by virtue of the power to issue money, can furnish the currency to pay all bills.

The object of this elaborate scheme—this pyramid of credit—is to supply the Government with the means to go off and fight the War by itself, leaving us, the people, to go on with business as usual, undisturbed. The weakness in the scheme is that it does not provide the Government with army, navy, or equipment. These can be had only by taking men—labor—out of peace employments and placing them in the employ of the Government; but when this is done, they go off our private payrolls and upon the Government's payrolls, and if we will now pay into the Treasury what we formerly paid to them, or for the things they were making, there will be no need for a pyramid of credit.

There is a theory that this war task can be handled somehow by increased energy and out of resources heretofore in reserve; but the demands of the Government are very elastic; they amount to all it can get. The more men we can send to France the better, the more cannon we can put on the line the better, the more ships and aeroplanes and supplies we can send, the better. And finally the more people we can keep on the farms and send back to the farms, the better.—National City Bank Circular, February 1918.

CAPE-TO-CAIRO TIME-TABLE

The first north-to-south Trans-African time-table has been prepared and is given below.

Section 1 (4 days; 1490 miles): Port Said to Cairo by rail, 5 hours; Cairo to Shellal by rail, 23 hours; Shellal to Wady Halfa by steamer, 42 hours; Wady Halfa to Khartum by rail, 24 hours.

Section 2 (21 to 24 days; 1411 miles): Khartum to Redjaf by steamer, 14 days; Redjaf to Nimule on foot, 5 to 8 days; Nimule to Butiaba by steamer, 2 days.

Section 3 (5½ days; 424 miles): Butiaba to Masinde by motor road, 10 hours; Masinde to Namasagali by steamer, 2 days; Namasagali to Jinja by rail, 1 day; Jinja (across Lake Victoria-Nyanza) to Muansa by steamer, 2 days.

Section 4 (13 days; 520 miles): Muansa to Tabora by road, 10 days; Tabora to Kigoma on Lake Tanganyika by rail, 2 days; Kigoma across Lake Tanganyika to Albertville by steamer, 1 day.

Section 5 (8 days; 566 miles): Albertville to Kabalo by rail, 1 day; Kabalo to Bukama by steamer, 7 days.

Section 6 (8 days; 2600 miles): Bukama to Kambove by rail, 1 day; Kambove to Elizabethville by rail, 1 day; Elizabethville to Bulawayo by rail, 3 days; Bulawayo to Cape Town by rail, 3 days.

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Industrial Progress

HELP LAUNCH A SHIP

*Who says we can't build ships?

Come on, you loyal American mechanics, masters of familiar trades, and brand this 'made in Germany' insinuation by building a bridge of ships to Pershing!

You can't do your country a greater service than by exchanging your good American brawn and skill for good American dollars—in the shipyards; and you'll do as much to win the War as the men dependent upon you in the trenches. Ships and men constitute the pivot on which the destiny of this country turns, and Uncle Sam is looking for 250,000 U. S. shipyard volunteers to build them.

Listen! Every rivet driven in the shipyards brings us

THE MAN OF THE HOUR

nearer to the successful termination of the War. To do our share our shipbuilding program demands 6,000,000 tons per year, or over a thousand ships. We must have them in order to win. We must have them to keep the wheels of American industry moving and American labor employed in the factories.

The Shipping Board has the money, the materials, and the yards to carry out this 6,000,000-ton program, but it needs men to assure these thousand yearly launchings which will hurl their tidal wave toward Germany. There must be an immense reserve of earnest skilled labor to draw on as fast as plants are completed in the yards and the housing provided.

This, then, is the purpose of this message—to ask your enrollment as a shipyard volunteer, for work in the shipyards when needed. Back up Uncle Sam and the millions of your brother workmen by your enrollment.

*Editorial of the Associated Business Papers, New York.

This does not mean that you are to give up your regular job and rush off to some shipyard that, at the moment, may not be able to accommodate you. Your enrollment simply shows that you stand ready, when called upon, to do a particular job for a particular wage in a particular place. Everything will be in readiness for you, and you will lose no time. So highly does the Government think of your services that you are placed in a deferred class in the draft, as long as you are working on ships.

"But," you say, "I've never worked on shipbuilding."

That's exactly why Germany thinks that America cannot build ships. Germany knows that there are not enough men in America who have actually worked on ships to make more than a tenth of the ships needed if we are to do any fighting worth while.

Here is where you American workmen can fool the Kaiser.

Ships are not things of mystery; they are merely big buildings afloat—the product of everyday skill and industry—and the American mechanic (hats off to him) can build them.

Familiar trades—your trade—are the ones that build ships; and almost all trades are represented. Two-thirds of the occupations required in shipbuilding are common to other industries, like boiler making, car building, bridge building, carpentering, and machine-shop work. The list given later indicates some of the classes needed. Read it carefully and see how you qualify. If you possess the right sort of train-

THIS IS YOUR BADGE OF HONOR—WEAR IT PROUDLY

ing now is the time to rally round this movement and wear a Badge of Honor. This button, issued by the United States Shipping Board, shows that the wearer, through enrollment in the United States Shipyard Volunteers, has placed the welfare of the Nation above all else and stands ready by his labor to help throw across the seas a bridge of ships by which the armies of the United States can pass to do their duty on the fields of France. To wear this button is a sign of distinction. It truly stamps the owner as the man of the hour, in whose hands rest the happiness and security of every man, woman, and child in this country.

Come on men—250,000 of you! Your Government is asking that you answer the rattle of German machine guns with the rattle of the riveter. It is asking you, for the present, to prove that you are the marrow of Americanism by going on record with an expression of your willingness to help build ships where you are needed; and it meets you half-way with good wages.

Can you turn a deaf ear to the call? Where can you qualify in the following list?

The classes of skilled workers needed are the following:

Acetylene and electrical welders
Asbestos workers
Blacksmiths
Anglesmiths
Drop-forge men
Foundry workers
Laborers, all kinds
Loftsmen
Template makers
Machinists and machine hands, all sorts

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Flange turners	Helpers
Furnace men	Painters
Boiler makers	Plumbers and pipe fitters
Riveters	Sheet-metal workers
Reamers	Coppersmiths
Carpenters	Shipfitters
Ship carpenters	Structural iron workers
Dock builders	Riveters
Chippers and calkers	Erectors
Electrical workers	Bolters up
Electricians	Other trades
Wiremen	Cementers
Crane operators	Crane men

Edward N. Hurley, head of the United States Shipping Board, is the mouthpiece of Uncle Sam in this call for shipyard volunteers. He has complete information on hand, ready to mail you, regarding method of enrollment and other details you may want to know. The coupon below is for your convenience in writing. Don't delay. Fill in the information asked for, clip and mail. Your action in this matter will bring you full particulars.

Show that you are interested by clipping the coupon now, while it is before you. The full story will then be mailed you.

Edward N. Hurley, Chairman,
U. S. Shipping Board,
Washington, D. C.

I wish you would send me at once further information, telling me how I can enroll as a member of the U. S. Shipyard Volunteers of the Public Service Reserve for employment in shipyards and so help win the War.

My Trade is .....

My Name is .....

Street Address .....

Town .....State.....

HELP TRANSPORTATION

The growing difficulties of freight transportation has induced the Associated Business Papers, Inc., New York, through their executive committee, to formulate a plan for definite practical co-operation by shippers to relieve terminal congestion and to keep freight moving. Neither the efficient control of Government bodies, nor the wisdom of the railroad men can solve the whole problem. A large part of the trouble is the local and short-haul difficulty, resting in congestion which extends back into the main arteries of transportation. Business men in all lines of endeavor should realize that they are not merely buyers of transportation, at a price per mile or per ton, but that adequate transportation service is absolutely necessary to the profits of business. At the present time interest charges on goods in transit frequently amount to more than double the cost of the transportation, while the cost of waste, due to inability to secure materials and to ship goods, runs into larger figures.

The Government having now assumed control of the railroads, and Director General McAdoo having surrounded himself with a staff of practical railroad operators; a National Highway Committee having been appointed with Roy D. Chapin, president of the Hudson Motor Car Co., as its head, with the Board of National Waterways Association working with the official committee on this problem, it is our recommendation that the matter will be best served by full co-operation with these governmental bodies. It is time to quit kicking about rules established to clear the tangle, and to co-operate in a whole-hearted and intelligent way.

It is recommended that the shipper should be urged to foster the following:

For Improvement of Railroad Service

(1) The provision of adequate rules to secure full efficiency.

(2) To establish proper charges for freight and demurrage and enforce equitable rules for loading and unloading, shipping and packing.

For Highways

(1) Extension of paved highways.

(2) Provision for keeping them open at all seasons.

(3) Proper provision for their maintenance.

For Waterways

(1) Construction of barges and small tow-boats to provide for the adequate use of existing highways.

(2) Provision for putting into shape existing waterways that had been allowed to become obsolete.

(3) Provision for the extension of these waterways to correlate with the railroad system.

Assisting the Railroads

(1) Co-operate without hesitation; do not object to changes.

(2) Load and unload promptly; do not wait for a convenient season.

(3) Load to capacity.

(4) Do not re-consign en route; decide upon the destination before the goods leave.

(5) Pack securely and mark plainly.

Aiding the Highways

(1) Make a survey of all incoming and outgoing freight handled within zones 10, 25, 50, or 75 miles from your city.

(2) Ship all goods to be delivered within the above zones over the road by motor-trucks.

(3) Demand that all goods to be shipped to merchants in your city, and originating within the zones mentioned, be delivered by motor-trucks.

(4) Make a census of all motor-trucks in your town available for this work.

(5) Take up with your local offices of the national express companies and your local haulage and express concerns as to how far they can extend their present delivery routes.

(6) Select a committee of the best traffic managers of concerns in your city to lay out a detailed plan to suit your local conditions, and determine upon fair rates to be charged.

(7) Arrange for a sufficient number of receiving platforms or warehouses where you can use horse wagons and motor-trucks up to 3-ton capacity to deliver and set down goods, leaving for the larger trucks the running between the main points in the zones. Do not try to make the trucks running overland between the main points do pick-ups and deliveries. It cuts down their efficiency and makes the maintenance of schedules impossible.

(8) Put some trucks in the overland-haul work on definite leaving schedules so that goods can be delivered to the receiving platforms or warehouses in time to make up full loads to any given points.

(9) Arrange a Return Loads Bureau. Arrange with the local telephone companies to give your regular telephone number to any inquirer asking for the Return Loads Bureau. Post notices in the offices of your merchants that you have established a Return Loads Bureau. Post similar notices in conspicuous places in the smaller towns and cities through which trucks, running to or from your city, will have to pass. This will enable your trucks, and those of private truck contractors, to quickly collect loads.

(10) Bring pressure to bear upon your mayor and the

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governor, and then to your highway commissioners, to keep the main highways leading out of your city open during the remaining winter months.

(11) Bring pressure to bear on the proper authorities to resume construction of main-line highways at the earliest possible moment this spring, and to maintain the roads throughout the year.

THE NEED OF PAINT ON FARMS

Millions of dollars a year could be saved to the farmers of the country through a more judicious use of paint. Houses, barns, farm implements, and equipment are allowed to decay when a few dollars invested in a good preservative paint would prolong their life of usefulness and decrease the yearly expense for replacement and repairs. The country's yearly loss resulting from failure to paint is often greater than the loss from fire. Farmers take insurance to cover loss by fire and should just as surely use paint to cover loss by decay. This is especially important today when farm machinery and equipment should be kept as efficient as possible and conserved in order to reduce the demand for materials and labor that are needed for other purposes.

Engineering Societies

Idaho Society of Engineers. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of **American Society of Mechanical Engineers.** Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of **American Institute of Electrical Engineers.** Edward Woodbury, secretary, 255 East 3rd street.

Oregon Society of Engineers. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, **American Institute of Electrical Engineers.** Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of **American Society of Civil Engineers.** J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Section of **American Society of Civil Engineers.** N. A. Bowers, secretary, Rialto building.

San Francisco Section of **American Society of Mechanical Engineers.** Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of **American Institute of Electrical Engineers.** A. G. Jones, 811 Rialto building.

Southern California Association of Members of **American Society of Civil Engineers.** Wilkie Woodward, secretary, 435 Consolidated Realty building, Los Angeles.

Utah Society of Engineers. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

Personal

F. T. Georgeson, of Eureka, California, has enlisted in the 33rd Engineers.

H. H. Welsh has gone to Washington to serve as assistant to **M. L. Requa,** Federal Oil Administrator.

R. P. Schwerin, formerly vice-president and general manager for the Associated Oil Co., has resigned.

Thomas Riggs Jr. member of the Alaskan Engineering Commission, has been appointed governor of Alaska.

S. A. Guiberson has been given charge of pipe-line distribution of oil under **M. L. Requa,** Federal Oil Administrator.

Milo B. Williams, F. C. Scobey, A. A. Rogers, and **J. J. Dean** are engaged in a survey of the tract near Durham, California, that is soon to be opened for settlement by the State Colonization Board.

H. A. Lage, formerly superintendent for the Crocker-Huffman Land & Water Co., has resigned. He has been succeeded by **L. D. Van Horn.**

Gratz Helm has been appointed receiver for the Honolulu Consolidated Oil Co., pending the outcome of the Government's suit against the company.

Thomas W. Ransom has been appointed chief inspector in charge of southern Californian shipbuilding for the U. S. Shipping Board with headquarters at Los Angeles.

The city council of Berkeley, California, has appointed a harbor commission composed of **E. C. Bradley, Joseph Gunn, H. W. Taylor, E. E. Nichols,** and **J. J. Jessup.**

Loyall A. Osborne, vice-president of the Westinghouse Electric & Manufacturing Co., has been appointed member of the Committee on Industrial Peace that is to serve during the War.

The following officers have been elected by the American Concrete Pipe Association to serve for the coming year: **John L. Zeidler,** president; **W. E. Goodman,** vice-president; and **J. H. Libberton,** secretary.

Wilson G. Harger has been appointed district engineer for the U. S. Office of Public Roads, with headquarters at Ogden, Utah, succeeding **C. G. Morrison,** who has gone to Alaska as district engineer of roads for the War Department.

Charles H. Lee, formerly of Los Angeles, is now with a water-supply regiment in France. His address is First Lieutenant Charles H. Lee, Engineers, U. S. R., care Chief Engineer Officer, Water Supply Section, A. E. F., Military P. O., 706, France.

H. P. Boardman, professor of civil engineering at the University of Nevada, has gone to Charleston, West Virginia, to take part in the construction of the plant for making high explosives that the Federal Government is building in that vicinity.

John H. Lewis, State engineer of Oregon, addressed a joint meeting of the Utah Society of Engineers and the Salt Lake section of the American Institute of Electrical Engineers, March 20, on 'Western Development and Its Relation to Transportation Policies.'

The resignation of **James T. Narbett** from the Engineer Officers' Reserve Corps has been accepted in order that Mr. Narbett may take charge of the construction of the new plant for making trinitrotoluene that the Hercules Powder Co. is erecting at Hercules, California.

J. H. Hoskins, who has been acting county surveyor of Stanislaus county, California, since **E. H. Annear,** the former county surveyor, joined the 20th Engineers, has been appointed county surveyor. Mr. Hoskins has made the following appointments. **Lloyd Aldrich,** assistant highway engineer; **T. B. Townsend,** chief deputy county surveyor; and **J. T. Maguire,** chief draftsman.

The following officers have been elected by the American Road Builders' Association to serve for the coming year: president, **H. E. Breed;** first vice-president, **W. W. Crosby;** second vice-president, **A. B. Fletcher;** third vice-president, **A. H. Blanchard;** secretary and treasurer, **E. L. Powers;** directors, **H. L. Bowlby, W. H. Connell, A. R. Hirst, J. W. Hunter, N. P. Lewis, H. G. Shirley,** and **W. R. Smith.**

Commercial Paragraphs

The Westinghouse Electric & Manufacturing Co. has issued a circular on 'Electrical Equipment in the Woodworking Industry.'

The Tiffin Wagon Co. has issued a 16-page pamphlet on 'Street Flushing,' describing the various motor-driven street-flushers manufactured by the company.

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Construction News Summary

STREET AND ROAD WORK

Astoria, Ore.—Following bids were received for construction of Smith Point highway: J. H. Tillman Co., 1½-in. asphaltic concrete on 6-in. concrete base, $9989.40. Miller & Bauer, 1½-in. asphaltic concrete on 6-in. concrete base, $15,320; bitulithic on concrete base, $15,522.52; brick on concrete base, $18,325.64. Engineer's estimate was $13,031.30.

Buckley, Wash.—Contracts for paving one mile of the Buckley road and two miles of the Orting road have been awarded to F. L. Sheldon for $18,000 and $33,000, respectively.

Colfax, Wash.—Contract for construction of section A of the Steptoe-Ewan road, 7 miles, has been awarded to Mitchell Bros., Spokane, for $69,850. Contract for construction of section B, 7.8 miles, has been awarded to Clifton, Applegate & Toole, Spokane, for $66,434. Contract for construction of section C, 8 miles, has been awarded to C. H. Greene, Spokane, for $75,965.

Contract for surfacing 8.75 miles of the Colton-Pullman road with crushed rock has been awarded to J. L. Strickler, Spokane, for $58,000. Mitchell Bros. bid $60,300.

Spokane Bitu-Mass Co. bid $59,200 and Mitchell Bros. $61,000 for surfacing 9 miles of highway running southwest from Colfax. Both bids were rejected.

Coquille, Ore.—Contract for graveling the Bandon-Curry highway, 11 miles, has been awarded to Dyer & Plymale, Bandon, for $0.87 per cu. yd. or $49,416 in all.

Eureka, Cal.—Following bids were received for macadamizing several alleys: Taggart & Kelly, $1987; J. F. Devoy, $2400; Elsemere & Jacobs, $2474. Bids were rejected and new plans will be prepared, calling for concrete pavement.

Los Angeles, Cal.—Contract for grading and construction of oil-macadam pavement 18 ft. wide and 5 in. thick on highway between Lancaster and Redman, 18 miles, has been awarded to Charles D. Soteras, Black Bdg., Los Angeles, for $223,000.

Contracts for grading and oiling parts of Oregon street, 76th street, and Del Mar avenue have been awarded to William Liddington, 420 East 60th street, Los Angeles, for $5014.97, $1129.33, and $1307.88, respectively.

Contract for improvement of New Hampshire boulevard has been awarded to W. R. Hefley, Wilcox Bdg., Los Angeles, for $1189.10.

Contract for improvement of Hartford avenue has been awarded to George R. Curtis, 2440 East 26th street, Los Angeles, for $6991.96.

Missoula, Mont.—Bids will be received until April 13 at office of District Engineer, U. S. Office of Public Roads, for construction of four miles of highway near Alberton.

Oakland, Cal.—Contract for improvement of East 32nd street has been awarded to J. Catucci, 1212 18th avenue, Oakland, at the following unit prices: excavation, $0.45 per cu. yd.; redwood curbs, $0.12 per ft.; concrete gutters, $0.145 per sq. ft.; oil-macadam pavement, $0.925 per square foot.

Olympia, Wash.—Following bids were received for grading and draining two miles of the Inland Empire highway south of Oakdale: Wilson & Hastings, $25,267; Mitchell Bros. & Edwards, $25,700; H. C. Malott, $27,991; J. A. Fletcher, $31,517. All bids were rejected and work has been postponed indefinitely.

Contract for clearing, grading, and draining four miles of the National Park highway has been awarded to J. C. Hendricks, Mossy Rock, the only bidder, for $21,633.

No bids were received for draining, grading, and surfacing eight miles of the Sunset highway between Creston and Wilbur.

Following bids were received for graveling one mile of the Pacific highway between Toledo and Forest: Standard Transfer Co., $6557.50; J. F. Ward, $6762; J. C. Hendricks, $6894; Albers & Son, $7167.50. All bids were rejected and work will be done by day-labor under direction of the State Highway Commission.

Oroville, Cal.—Chico Construction Co., Chico, was low bidder for construction of macadam road near Richvale. Brush-Howard Co. also bid on this work. Bids were rejected and work will be done by day-labor under the supervision of county surveyor, Martin Polk. Estimated cost is $6000.

Brush-Howard Co. was low bidder and was awarded contract at 4.7c. per sq. ft. for macadamizing the river road near Chico. Chico Construction Co. bid 4.75 cents.

Porterville, Cal.—Bids will be received until April 8 by city clerk for construction of 1½-in. warrenite pavement on 5-in. concrete base on highway from Luther Burbank park to city limits.

Redwood City, Cal.—Bids will be received until April 15 by city clerk for improvement of Vera avenue.

Riverside, Cal.—Johnson-Shea Co., Box 906, Riverside, was the only bidder at $248,500 for construction of about 20 miles of water-bound gravel-macadam highway in the vicinity of Blythe.

Sacramento, Cal.—The following unit prices were named by E. S. Groshong, Burbank, who was low bidder for construction of 1.9 miles of State highway in San Diego county through the town of Oceanside: excavation, $0.90 per cu. yd.; 18-in. corrugated pipe, $1 per ft.; concrete in culverts and monuments, $10 per cu. yd.; concrete in pavement, $6.25 per cu. yd.; guard-rail, $0.75 per ft.; monuments, $1 each; a total of $15,874.75. Other bidders were G. W. Tuttle Co., $18,062.78; W. N. Hendricks and M. S. Cummings, $22,793; Edward Gyles, $24,960.50. Engineers' estimate was $17,386.74. State will furnish reinforcing-steel, corrugated pipe, pipe-railing, and cement valued at $8618.36.

The following unit prices were named by Mercer-Fraser Co., Eureka, for grading 6.2 miles of State highway in Humboldt county between Eureka and Arcata: excavation, $0.3175 per cu. yd.; 24-in. corrugated pipe, $2 per ft.; concrete in culverts and monuments, $20 per cu. yd.; monuments, $0.50 each; a total of $48,849.50. Other bidders were Humboldt Dredging Co., $70,215; Palmer & McBryde, $79,691; Conners, Green & Co., $98,044; F. Rolandi, $114,274.

Federal Construction Co., Sharon Bdg., San Francisco, was low bidder and was awarded the contract for paving 6.7 miles of State highway in Santa Cruz and a point three miles south of Glenwood at the following unit proces: excavation, $0.75 per cu. yd.; 12-in. corrugated pipe, $0.60 per ft.; 15-in. pipe, $0.75 per ft.; concrete in culverts, $12.50 per cu. yd.; concrete in pavement, $5.93 per cu. yd.; a total of $48,530.80. Other bidders were Bates & Borland, $56,329.20; Palmer & McBryde, $62,274.80; J. A. Marshall, $64,866.40. Engineers' estimate was $48,738.84. State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate valued at $35,125.

The State highway work at Riverbank in Stanislaus county, bids for which will be received until April 8 by State Highway Commission, requires 6400 cu. yd. excavation, 60 ft. of 12-in. corrugated pipe, 2 cu. yd. concrete in culverts and monuments, 475 cu. yd. concrete in pavement, 800 ft. of guard-rail, 11 monuments, and an over-grade crossing over the Santa Fe railroad tracks. This crossing will require 213 cu. yd. class A concrete in the superstructure, 300 cu. yd. class C concrete in the abutments and footings, 30,900 lb. reinforcing-steel, 200 lb. structural steel, and a lighting system. State will furnish reinforcing-steel, corrugated pipe, cement, sand, coarse aggregate, manhole castings, and bearing-plates.

No formal bids were received for construction of three miles of highway in Riverside county near Indio. Three informal bids were received, the lowest being that of Johnson-Shea Co., Riverside, at the following unit prices: excavation, $0.70 per cu. yd.; 18-in. corrugated pipe, $1 per ft.; concrete in culverts and monuments, $15 per cu. yd.; concrete in pavement, $8.30 per cu. yd.; monuments, $2; a total of $30,582. G. M. Souter bid $32,764.50 and J. S. Miller, $33,734.40. Engineers' estimate was $29,590.10. State will furnish reinforcing-steel, corrugated pipe, and cement valued at $12,938.50. All bids were rejected.

San Diego, Cal.—Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, was low bidder at 13c. per sq. ft. for construction of concrete pavement with asphaltic surface on El Capitan, San Marcos, and Laurel streets.

San Francisco, Cal.—Contract for improvement of parts of Taraval street between 33rd and 37th avenues has been

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awarded to State Improvement Co. at the following unit prices: concrete curbs, $0.94 and $0.98 per ft.; asphalt pavement, $0.28 and $0.29 per sq. ft.; brick catch-basins, $110 each; concrete sidewalks, $0.16 per sq. ft.; 10-in. vitrified culverts, $2 per foot.

Contract for improvement of Naples street between Brazil and Excelsior avenues has been awarded to Flinn & Treacy at $0.90 per ft. for concrete curbs and $0.26 per sq. ft. for asphalt pavement.

Contract for improvement of Whittier street between Brunswick and Morse streets has been awarded to S. F. Johnson at 85c. per ft. for concrete curbs and 28c. per sq. ft. for asphalt pavement.

Contract for improvement of Revere avenue between Ingalls and Jennings streets has been awarded to Flinn & Treacy at the following unit prices: concrete curbs, $0.70 per ft.; brick catch-basins, $85 each; 10-in. vitrified culvert, $1 per ft.; concrete sidewalks, $0.11 per sq. ft.; asphalt pavement, $0.195 per square foot.

Contract for improvement of parts of Division street, 8th street, and Townsend street has been awarded to Fay Improvement Co. at the following unit prices: asphalt pavement, $0.21 per sq. ft.; granite curbs, $0.94 per sq. ft.; concrete sidewalks, $0.13 per sq. ft.; brick catch-basins, $84 each; 10-in. vitrified culverts, $1.38 per foot.

City engineer M. M. O'Shaughnessy has completed plans for extending and widening Market street as far as 24th street. Estimated cost is $214,650.

Contract for improvement of Quesada avenue between Ingalls and Jennings streets hase been awarded to Flinn & Treacy at $0.26 per sq. ft. for asphalt pavement and $0.80 per ft. for concrete curbs.

Contract for improvement of Clipper street between Diamond and Douglass streets hase been awarded to Fay Improvement Co. at $0.48 per sq. ft. for brick pavement, $0.28 per sq. ft. for asphalt pavement, and $0.80 per ft. for concrete curbs.

Contract for improvement of Teddy avenue between Delta and Elliot streets has been awarded to C. B. Eaton at the following unit prices: asphalt pavement, $0.22 per sq. ft; brick pavement, $0.42 per sq, ft.; concrete curbs, $0.70 per ft.; concrete sidewalks, $0.14 per sq. ft.; brick catch-basins, $75 each; 10-in. vitrified culverts, $1 per ft.; 8-in. sewer, $2 per foot.

Contract for improvement of Vicksburg street between Jersey and 25th streets has been awarded to J. F. Dowling at $0.26 per sq. ft. for asphalt pavement, $0.14 per sq. ft. for concrete sidewalks, and $1.50 per ft. for granite curbs.

Contract for improvement of Chenery street near Diamond street has been awarded to J. F. Lorenz at the following unit prices: concrete curbs, $0.80 per ft.; concrete sidewalks, $0.15 per sq. ft.; asphalt pavement, $0.2675 per sq. ft.; 2-in. asphaltic wearing surface, $0.10 per sq. ft.; brick catch-basins, $120 each; 10-in. vitrified culverts, $1.50 per ft.; 8-in. culverts, $1.40 per foot.

Santa Ana, Cal.—County surveyor J. L. McBride is preparing plans for highway from Laguna Beach to Newport bay.

Santa Cruz, Cal.—Contract for improvement of Ocean View avenue has been awarded to B. Byrne, 116 Soqul avenue, Santa Cruz, for $9752.25. Other bidders were Granite Rock Co., $10,352.17; W. E. Miller, $10,654.

Seattle, Wash.—Bids will be received until April 8 by county commissioners for construction of the Wayne-Juanita and Juanita-Houghton road, and until April 9 for construction of the Auburn Enumclaw road.

Bids will also be received until April 12 for grading and graveling three miles of the Wilkenson road.

Bids will also be received until April 22 for grading and graveling one mile of highway near Juanita point.

Contract for construction of concrete pavement on Ewing street has been awarded to R. G. Stevenson for $5430. James Construction Co. bid $6083.50.

Contract for construction of brick pavement on Stone way has been awarded to F. N. Badolato for $17,784.75. R. G. Stevenson bid $18,433.75 and V. Bressi, $18,562.20.

Contract for paving Colorado avenue has been awarded to James Construction Co., 812 Second avenue, North, Seattle, for $13,805.

South San Francisco, Cal.—Contract for construction of concrete curbs, sidewalks, and gutters on several streets has been awarded to M. A. Greely, 948 Market street, San Francisco.

Spokane, Wash.—Following bids were received for raising the grade and construction of pavement, curbs, and sidewalks on East Trent avenue: Spokane Bitu-Mass Paving Co., $53,289 for one-course concrete pavement and $57,683 for sheet asphalt on concrete base. Clifton, Applegate & Toole, $53,750 and $57,800; Standard Asphalt Paving Co., $55,618 and $60,281. All bids were considerably more than the engineers' estimate.

St. Helens, Ore.—Contract for construction of two miles of St. Helens-Nehalem road has been awarded to Hehart & Mills for $15,290.

The Dalles, Ore.—Contract for construction of macadam highway between The Dalles and Dufur has been awarded to Dahl & Dahl, Tygh Valley, for $28,000.

Vallejo, Cal.—Worswick Construction Co., Vallejo, was awarded contract for construction of concrete sidewalks on several streets at $1 per cu. yd. for excavation and $0.14 per sq. ft. for sidewalks, a total of $8153.10. Horan Co., Vallejo, bid $9327.50, and Pacific Concrete & Mosaic Works, San Francisco, $9958.25. This contract will complete the construction of sidewalks on all improved streets.

Visalia, Cal.—Bids will be received until April 2 by George R. Prestidge, county clerk, for construction of four miles of concrete highway from Strathmore west.

Contract for construction of concrete highway from Porterville to Worth, 4.77 miles, has been awarded to Concrete Pipe & Construction Co., Porterville, at $0.90 per cu. yd. for excavation, and $4.10 per cu. yd. for concrete pavement.

Concrete Pipe & Construction Co. was low bidder for construction of Orosi-Orange Cove and Yettem-Elderwood divisions of county highway system. Bids were rejected.

All bids for construction of concrete pavement on Merryman-Lemon Cove division, 9.27 miles, have been rejected and new bids will be received until April 2 by George R. Prestidge, county clerk.

Walla Walla, Wash.—Contract for completion of gravel highway from Walla Walla to Wallula has been awarded to L. Laning for $15,474.

Waterville, Wash.—Contract for construction of permanent highway No. 1-A has been awarded to Davenport & Picken, Omak, for $18,700, who were also awarded contract for construction of permanent highway No. 4-A for $13,300.

Willows, Cal.—Contract for grading, graveling, and surfacing with asphaltic mixture one mile of highway near Willows has been awarded to Brush-Howard Co., Santa Rosa, for $3000.

SEWERS AND DRAINAGE

Everett, Wash.—No bids were received for construction of relief sewer from 19th and 21st streets, and work will be done by day-labor.

Isleton, Cal.—State Board of Health has approved plans for septic tank to be constructed by town.

Jerome, Ariz.—William B. Arndt, Box 655, Jerome, was low bidder and was awarded contract at $32,296 for construction of sewer system.

Redwood City, Cal.—Contract for construction of sewer on Chestnut street has been awarded to A. Hess & Co., Redwood City, for $2425.80.

Richmond, Cal.—Following bids were received for construction of sewer in north-western part of city north of Santa Fe tracks: Fred Meyer, $5693.10; W. J. Tobin, $5927.42; R. H. Downer, $6492.14; F. E. Clynch, $5992.60; L. L. Page, $7174; S. C. Rogers, $7216.44.

Richvale, Cal.—Bids will be received until April 6 by C. B. Harris, secretary drainage district No. 100 for construction of about 60 miles of lateral drains. Estimated cost is $70,000. F. S. Robinson, Chico, is engineer.

Construction of drainage system in district No. 833 will probably be postponed indefinitely.

Riverside, Cal.—Bids will be received until April 10 by city clerk for construction of sewer on Miller street.

San Francisco, Cal.—Contract for construction of sewer on Phelps street and on Williams avenue has been awarded to J. F. Lorenz at the following unit prices: 2 by 3 ft. reinforced concrete sewer with part of the invert lined with brick, $5 per ft.; 21-in. sewer, $3 per ft.; wye-branches for 21-in. sewer, $4 each; 6-in. vitrified underdrain, $0.30 per ft.; 8-in. vitrified underdrain, $0.45 per ft.; brick or concrete manholes, $100 each; building junction-structure between 2 by 3-ft. reinforced concrete sewer and existing 5 ft. 9-in. sewer, $216.

Santa Barbara, Cal.—Contract for construction of a screen-system sewage disposal plant for city sewage has been awarded to W. M. Ledbetter, Los Angeles, for $31,945.

Seal Beach, Cal.—John Heafy bid $52,000 and I. N. Miletich & Co. $59,743.25 for construction of sewer system. As there is only $45,000 available for the work bids were rejected and the work will be re-advertised.

Stockton, Cal.—Contract for construction of 24-in. re-

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inforced concrete sewer from the north disposal plant to the San Joaquin river has been awarded to Frank C. McIntire, 406 North Aurora street, Stockton, for $13,092.40. John Heafy bid $13,092.30. Engineer's estimate was $13,000.

BRIDGES AND CULVERTS

Colfax, Wash.—Contract for construction of two bridges on the Steptoe-Ewan road has been awarded to H. C. Malott, Seattle, for $13,730.

Eureka, Cal.—Bids will be received until April 9 by Fred M. Kay, county clerk, for construction of bridges across Willow creek and across Mad river.

Knights Landing, Cal.—Contract for construction of bridge over Knights Landing Ridge cut, consisting of timber trestle 165 ft. long and steel and timber bridge 78 ft. long, has been awarded to Jenkins & Wells, Sacramento.

Porterville, Cal.—Contract for construction of pile-trestle approaches and concrete abutments for steel bridge to be built by Santa Fe Railroad across Tule river has been awarded to Sharp & Fellows Contracting Co., Central Bdg., Los Angeles. Work will require 1400 cu. yd. concrete.

Portland, Ore.—State Highway Commission has awarded contract for construction of Hood River bridge to Parker & Banfield, Portland, for $35,914, and contract for construction of bridge near Dillard to Portland Bridge Co., Portland, for $18,732.

Sacramento, Cal.—War Department will oppose construction of any bridges between Rio Vista and Walnut Grove, but will not object to construction of bridge north of Isleton.

San Francisco, Cal.—Contract for steel work for viaduct across the Embarcadero at the foot of Market street has been awarded to Ralston Iron Works, San Francisco, for $19,865.

San Luis Opisbo, Cal.—Contract for construction of highway bridge across Berros creek has been awarded to T. Maino at $3950 for the work as specified, $4.50 per cu. yd. for wet excavation, $1.40 for dry excavation, $30 per cu. yd. for class A concrete, and $29 for class B concrete.

Seattle, Wash.—County commissioners will receive bids until April 9 for construction of steel bridge across the south fork of the Snoqualmie river at North Bend.

Gerrick & Gerrick Co., Central Bdg., Seattle, was low bidder and was awarded the contract at $45,391 for construction of superstructure for Eastlake Avenue bridge. J. R. Wood bid $57,412.50, and E. E. Davis & Co., $58,723.45.

Contract for construction of three steel bridges for the Spokane, Portland & Seattle Railroad Co. has been awarded to Gerrick & Gerrick Co., Central Bdg., Seattle, for $30,000.

St. Helens, Ore.—Contract for construction of Beaver Slough bridge has been awarded to J. B. Handley for $5200.

Waterville, Wash.—Contract for construction of the Foster Creek bridge has been awarded to C. G. Huber, Central Bdg., Seattle, for $9225. H. C. Malott bid $12,700.

IRRIGATION AND WATER SUPPLY

El Centro, Cal.—All bids for construction of reinforced concrete waste-gate four miles south of Calexico for Imperial irrigation district have been rejected. Work will probably be done by day-labor.

Blee & Sears were low bidders at $36,000 for construction of head-gate and drop-structure at New river for Imperial irrigation district. Other bidders were Edwards & Wildey Co., $39,000; W. M. Ledbetter, $52,000; Ross Construction Co., $59,000. Bids were rejected and the work will probably be postponed indefinitely.

Contract for construction of wooden head-gate near Calexico for Imperial irrigation district has been awarded to Edwards & Wildey Co., Black Bdg., Los Angeles, for $10,914. W. M. Ledbetter & Co. bid $15,352 and Mercereau Bridge & Construction Co., $17,200.

Edwards & Wildey Co. was also awarded contract for construction of wooden check-gate near Calexico at $10,200. W. M. Ledbetter bid $15,860 and Mercereau Bridge & Construction Co., $17,651.

Fillmore, Cal.—Thomas Haverty Co., 517 South Los Angeles street, Los Angeles, was low bidder at $25,364 for construction of extensions to municipal water system. Edwards & Wildey Co. bid $25,794.95 and C. Whipple, $29,612. Paul Ehlers, 5618 Harold way, Los Angeles, was low bidder at $12,000 for construction of circular reinforced concrete reservoir and C. Whipple was low bidder at $1440 for construction of pump-pit and pump-house. H. O. Young was low bidder at $3650 for furnishing pump and electric equipment.

Puente, Cal.—Contract for construction of a reinforced concrete reservoir for the La Puente Co-Operative Water Co. has been awarded to Clarence Whipple, Huntington Park, for $8532.50.

Riverside, Cal.—Contract for construction of 4600 ft. of 36-in. reinforced concrete water-pipe for city's main supply-main has been awarded to Western Reinforced Concrete Pipe Co., Los Angeles. Total estimated cost is $26,000. This pipe will replace a corroded steel pipe-line.

San Francisco, Cal.—State Water Commission has received the following applications to divert water for irrigation:

Sespe Light & Power Co., Los Angeles, water from Piru creek and Sespe river. Plans include 32 miles of canals and pipe-lines. This water may also be used for power.

Mallon & Blevins, Colusa, 100 second-feet from Sacramento river. Plans include motor-driven centrifugal pumps and canal 10½ miles long. Estimated cost is $80,000.

J. B. Thompson, Vina, water from Butte creek in Butte county and from creeks in Siskiyou county. This water may also be used for power and mining.

Littlerock irrigation district, Littlerock, flood-waters of Littlerock creek. Plans include storage dam costing $300,000.

G. L. Lamy, Los Angeles, 50 second-feet from Lake Elsinore. Plans include canal and pipe-line 35 miles long. Estimated cost is $300,000. This water is also to be used for power development.

Rice Lands & Products Co., Oakland, 70 second-feet by pumping from Sacramento river. Estimated cost is $12,000.

San Rafael, Cal.—Following were the unit bids for the construction of the main concrete pipe-line for the Main Municipal water district, the first figure being that submitted by J. D. Hannah and the second by Cahill & Vensano: Fairfax gate-house, $4000, $4600; Phoenix gate-house, $2000, $1750; eastern valve-pit, $500, $750; western valve-pit, $500, $750; concrete in trestles, 313 cu. yd., $40, $60; concrete in piers, 69 cu. yd., $50, $38.50; trenching and back-filling, 35,125 lin. ft., $1.25, $1.59; tunnel, 1190 cu. yd., $3, $3; extra width of trench in rock sections, 2000 lin. ft., $4, $4; 24-in. concrete pipe, 37,000 lin. ft., $2.25, $5; material in slides, 2000 cu. yd., $2, $4.50; total $164,821, $281,705. Bids were rejected and the contract has been awarded to Bent Bros., Los Angeles, on a cost-plus basis.

Santa Barbara, Cal.—Plans for the Gibraltar dam will be ready about May 1. This will be a single-arch dam of reinforced concrete 170 ft. high, and 100 ft. wide at the base. Quinton, Code & Hill, Hollingsworth Bdg., Los Angeles, are engineers.

Contract for construction of wood-stave pipe-line from Mission Ridge reservoir to connection with city system has been awarded to Redwood Manufacturers' Co., San Francisco, for $15,000.

Selah, Wash.—Contract for improvement of system for Naches-Selah irrigation district has been awarded to Nettleton-Bruce-Eschbach Co., American Bank Bdg., Seattle, on a cost-plus-fixed-sum basis. Estimated cost is $375,000. Work includes concrete-lined tunnel 7852 ft. long, 8000-ft. concrete-lined ditch, 1000-ft. reinforced concrete flume, and the lining of 20,000 lin. ft. of other ditches.

Tracy, Cal.—Bids will be received until April 9 by J. C. Chrisman, secretary West Side irrigation district, for work under contracts No. 14 and 15. Contract No. 14 comprises 500 cu. yd. excavation, 120 cu. yd. concrete, 10,000 lb. reinforcing-steel, and 10,000 ft. B.M. lumber. Contract No. 15 comprises 3000 cu. yd. excavation and 24 small bridges.

Contract for construction of railroad crossings for canals of West Side irrigation district has been awarded to J. E. Johnson, Tracy, for $5066.25. Other bidders were W. B. Esterly, $5591; Bos & O'Brien, $5798.50; and John Heafy, $7712.

Contract for construction of reinforced concrete siphons for highway crossings has been awarded by West Side irrigation district to Bos & O'Brien, San Francisco, for $15,210. Contract for construction of lateral head-gates, drops, and other structures has been awarded to J. E. Johnson, Tracy, for $8602.

LIGHT, HEAT, AND POWER

Bremerton, Wash.—NePage-McKenny Co., Seattle, was only bidder at $8950 for construction of power-transmission line at Puget Sound Navy Yard.

Corcoran, Cal.—Plans have been prepared for construc-

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tion of ornamental lighting system. Frank G. Cross is interested.

Los Angeles, Cal.—Contract for construction of lighting system on South Broadway has been awarded to Keystone Iron Works for $65,985.

Riverside, Cal.—Southern Sierras Power Co. will reconstruct 60 miles of main transmission line from power-plant on Rush creek in Mono county. Estimated cost is $270,000.

San Francisco, Cal.—State Water Commission has received the following applications for permission to divert water for power:

D. A. Syme, Kernville, 3 second-feet from tributary of Kern river, to develop 20 horse-power.

A. M. Wishart, A. Cameron, and J. E. Herrin, Yerington, Nevada, 20 second-feet in Mono county. Plans include loose-rock and concrete dam and a metal flume 3¾ miles long. Estimated cost is $48,000.

State Railroad Commission has recommended expenditure of $20,000,000 by hydro-electric companies operating south of Merced, $15,000,000 of which is to be by the Southern California Edison Company.

Seattle, Wash.—Following bids were received for construction of municipal hydro-electric plant: Grant Smith & Co., Henry Bdg., Seattle, plant on Skagit river, $4,297,000 for permanent construction, $2,381,000 for mainly timber construction. Plant on Skykomish river, permanent construction, $3,556,000. Puget Sound Bridge & Dredging Co., Central Bdg., Seattle, plant on Stillaguamish river, permanent construction, $4,200,000. None of these bids includes the cost of transmission-line, which city engineer A. H. Dimock estimates at $1,200,000 for the Skagit River and $500,000 for the Skykomish River site.

RIVER AND HARBOR WORK

El Centro, Cal.—Contract for raising 7½ miles of the Solfatara levee for the Imperial irrigation district has been awarded to Leroy Little, Calexico, for $0.35 per cu. yd. Work will require 141,921 cu. yd. embankment.

Portland, Ore.—Bids will be received until April 9 by Commission of Public Docks for construction of grain-elevator at municipal docks at St. Johns. Plans from Commission of Public Docks upon deposit of $50.

Contract for construction of municipal pier at St. Johns has been awarded to J. A. McEachern Co., Seattle, for $420,328. Harrington-Peters Co. bid $444,500 and Grant Smith & Co., $634,375. A. Guthrie & Co. submitted a bid on a cost-plus basis, but this bid was not considered.

Richmond, Cal.—Bids will be received until April 8 by A. C. Faris, city clerk, for construction of spur railroad trestle at the municipal wharf.

Sacramento, Cal.—Clark & Henery Construction Co., Sacramento, was the only bidder at about $36,000 for construction of levee along Sacramento river near Fruit Ridge road, requiring about 57,000 cu. yd. embankment.

San Francisco, Cal.—Pacific Building Materials Co. was low bidder and was awarded the contract at $10,379 for furnishing steel rolling doors for pier No. 3. Other bidders were Schrader Iron Works, $14,134; Waterhouse-Wilcox Co., $14,320.

State Board of Harbor Commissioners has awarded contract for construction of addition to Wells Fargo building to Robert Trost, 26th and Howard streets, San Francisco, for $23,589. Other bidders were B. Munson, $24,200; Schultz Construction Co., $24,747; Hayes-Oser Co., $24,987; Frank Gallagher, $25,147; Val Franz, $25,260; Isaac Penny, $25,980; P. F Riley, $25,985; Howard S. Williams, $26,188; J. S. Hannah, $26,487; O. C. Holt, $27,465; C. L. Wold, $29,621; Wagner Co., $31,343.

Contract for dredging in Oakland harbor under bids opened January 21 has been awarded to American Dredging Co., San Francisco, for $118,364.

Santa Barbara, Cal.—Contract for construction of wooden bulkhead on Mission street has been awarded to W. M. Ledbetter, Los Angeles, for $7950.

Seattle, Wash.—Contract for dredging in Lake Washington canal has been awarded to Puget Sound Bridge & Dredging Co., Seattle, the low bidder, at $92,750.

Stockton, Cal.—Contract for construction of levee near Edison street, including grading, paving, and the construction of concrete slips has been awarded to E. A. Burns for $3190.22. Other bidders were Clark & Henery Construction Co., $3352.70; W. H. Paul, $3721.27; F. C. McIntire, $4287.72.

Vancouver, B. C.—Contract for construction of freight-shed on Government dock has been awarded to Hodgson & King, Vancouver, for $128,274.

RAILROAD WORK

Alameda, Cal.—Bids will be received until April 9 by R. E. Bosshard, city clerk, for construction of a single-track railroad along Clement avenue from the westerly property-line of the Southern Pacific Railroad to Grand street. Alternative bids will be received as follows: First, for furnishing all materials, labor, and equipment; second, for furnishing labor and equipment; and third, for furnishing materials. Plans from city clerk upon deposit of $5.

Provo, Utah.—Salt Lake, Fillmore & Kanosh Railroad Co. has been incorporated to build railroad from Lynndyl to Kanosh, 50 miles. George W. Craig, Provo, is president.

San Diego, Cal.—Bids will be received until April 22 by Bureau of Yards and Docks, Navy Department, at Washington, D. C., and at San Diego, for construction of a marine railway at the naval coaling-station at La Playa.

Railroad will be built on North island to connect with San Diego & Arizona Railway. Part of this work will be done by the Federal government, and part by the company. Estimated cost is $85,000.

San Francisco, Cal.—Board of Public Works has been authorized to prepare plans for extension of municipal railroad from Twin Peaks tunnel westerly.

State Railroad Commission has denied petition of Pacific Electric Railway Co. to construct railroad from Anaheim to Irvine, 11 miles, and from Glendora to Lone Hill, 4 miles. Estimated cost was $440,000.

BUILDING CONSTRUCTION

Alameda, Cal.—Contract for construction of concrete and steel building for Union Iron Works has been awarded to Palmer & Peterson, Monadnock Bdg., San Francisco, for $60,000.

Contract for construction of frame office-building for Union Iron Works has been awarded to V. Franz & Son, 180 Jessie street, San Francisco, for $36,988.50.

Bay Point, Cal.—Contract for construction of first unit of Bay Point grammar school has been awarded to Matthew Morton, Richmond, for $13,137. Other bidders were P. M. Sanford, $13,635; Carl Overaa, $13,966; Olsen & Haladay, $14,795; R. Keller, $14,818; B. T. Owsley, $15,997; W. D. Henderson, $16,778; Grace & Bernieri, $17,207.

Biggs, Cal.—A. A. Plagge, Oroville, was low bidder and was awarded contract at $13,873.30 for construction of high-school building. Other bidders were W. R. Campbell, $13,990; H. A. Klyce, $14,200; W. C. Keating, $14,475; R. M. Smith, $15,200; W. Sorensen, $16,038.

Crows Landing, Cal.—Libby, McNeil & Libby will construct condensed-milk plant of reinforced concrete. Estimated cost is $100,000.

Dillon, Mont.—Contract for construction of dormitory at State Normal School has been awarded to W. G. Reed, Twin Falls, Ida., for $53,517. Other bidders were George H. Pew, Missoula, $59,500; Wemple & Holtz, Dillon, $63,595; T. Sontag, Anaconda, $72,145; L. Berg, Helena, $73,820.

Fresno, Cal.—A. G. Headman, Call Bdg., San Francisco, is preparing plans for hotel-building to be constructed on Tulare street. Estimated cost is $500,000.

California Associated Raisin Co. will construct reinforced concrete factory-building. Estimated cost is $300,000.

Klamath Falls, Ore.—Contract for construction of new courthouse has been awarded to J. M. Dougan, Portland, for $131,775, in spite of the fact that $180,000 has already been spent on an uncompleted building on another site. Injunction proceedings have been threatened.

Lodi, Cal.—Contract for construction of brick building for Lodi Investment Co. has been awarded to J. F. Sheperd, 1031 West Vine street, Stockton, for $28,500.

Long Beach, Cal.—Contract for construction of brick apartment-house for R. C. Dickens has been awarded to C. T. McGrew, 1345 West Ocean avenue, Long Beach, for $37,000.

Los Angeles, Cal.—Lepper & Laisey, 3704 West Washington street, Los Angeles, were low bidders for making alterations to State Exposition Building at Exposition park at $13,246 for one wing and $26,200 for both wings.

Mabton, Wash.—Mabton Elevator Co. will construct grain-elevator. Estimated cost is $25,000.

Mills, Cal.—Contract for construction of frame building

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for Government aviation school has been awarded to MacDonald & Kahn, Rialto Bdg., San Francisco. Estimated cost is $1,000,000.

Palo Alto, Cal.—W. L. Wasson, Palo Alto, will construct apartment-house. Estimated cost is $50,000.

Portland, Ore.—Siewart & Engstrom, Salem, were low bidders and were awarded contract at $16,780 for construction of first unit of stadium at State Fair Grounds.

Riverside, Cal.—Contract for construction of Arlington school has been awarded to L. C. Waldman for $32,000. Other bidders were Edwards & Wildey, $33,198; F. H. Ryerson, $34,788; Cresmer Manufacturing Co., $35,612; G. A. Daniels, $43,045. Contract for heating and ventilating was awarded to Riverside Sheet Metal Works for $4885. Carpenter & Timmins were low bidders at $2668 for the plumbing and sheet-metal work.

Sacramento, Cal.—Bids will be received until April 15 by W. F. McClure, State engineer, for construction of two cottages at the Agnews State Hospital, Agnew. Plans from State engineer upon deposit of $20.

The following were the low bidders on segregated contracts for construction of agricultural pavilion at Agricultural park: Carpenter work, including sheet-metal, composition-roofing, glazing, plastering, and painting, E. T. Leiter & Son, Call Bdg., San Francisco, $31,887; Architectural terra-cotta work, N. Clark & Son, 116 Natoma street, San Francisco, $5520. Tile roofing, Gladding-McBean Co., Crocker Bdg., San Francisco, $12,100. Ornamental iron work, Brombacher Iron Works, Los Angeles, $9770. Concrete and excavation work, Howard S. Williams, Hearst Bdg., San Francisco, $38,400. Masonry, including brick work and setting architectural terra cotta, H. Beckwith, 2419 19th avenue, Oakland, $60,900. Plumbing, sewers, and heating, F. W. Snook Co., 596 Clay street, San Francisco, $10,660. Electrical work, Latourette-Fical Co., Sacramento, $7585.

Plans are being prepared by A. H. Markwart, First National Bank Bdg., San Francisco, for plant for de-hydrating vegetables and fruits to be erected by the E. Clemens Horst Co. Estimated cost is $100,000.

George W. Cowen Co., Sacramento, will construct concrete and terra-cotta building. Estimated cost is $100,000. J. W. Woollett, Sacramento, is architect.

Phillips Rice Milling Co., 1523 Front street, Sacramento, will construct rice-mill. Estimated cost is $80,000.

San Francisco, Cal.—The following awards have been made for work on the reinforced concrete building for psychopathic ward at Letterman General Hospital: General construction to F. B. Peake, 1247 42nd avenue, for $43,391. Plumbing to A. Lettich, 365 Fell street, for $16,-799. Heating and ventilating to Burnham Plumbing Co., 1220 Webster street, for $4476. Electric wiring and fixtures to Electrical Construction Co., 604 Mission street, for $2352. All San Francisco firms.

California Alkali Co., Holbrook Bdg., San Francisco, has applied to Commissioner of Corporations for permission to issue stock to raise funds for extending and enlarging its plant at Cartago for making soda ash. Estimated cost is $360,000.

Bureau of Foreign and Domestic Commerce, 307 Custom House, has information regarding proposed re-building of a city recently destroyed by earthquake, presumably Guatemala City. Estimated cost of work is $1,000,000.

F. B. Peake, 1247 42nd avenue, San Francisco, was low bidder at $43,391 for construction of psychopathic ward at Letterman General Hospital. Other bidders were L. G. Bergren & Sons, $44,872; K. E. Parker, $45,950; C. L. Wold, $45,986; H. A. Klyce, $47,095; Barrett & Hilp, $49,476; F. Gallagher, $50,000; A. H. Vogt, $50,973; J. Collins, $54,145; Grace & Bernieri, $54,855; I. Penny, $62,290.

Following bids were received for construction of brick warehouse at Mission and Spear streets for George Billings, the first figure is for 70-ft. piling, the second, where given, is for 30-ft. piling: Walter Sorenson, $41,990; A. Gilson, $42,834, $40,474; Cameron & Disston, $44,300, $41,500; Palmer & Peterson, $45,547; Hansbrough Johnson Co., $41,752; Brandon & Lawson, $44,422; H. Klyce, $43,800, $41,000; Monson Bros., $44,247, $41,947; W. C. Duncan & Co., $41,067, $38,267. Contract was awarded to W. C. Duncan & Company.

Contract for construction of Levin Theatre has been awarded to Trevia & Pasqualetti, 400 Bay street, San Francisco.

Contract for construction of reinforced concrete building for J. D. and A. B. Spreckels at the corner of Spear and Harrison streets has been awarded to Clinton Construction Co., 140 Townsend street, San Francisco, for $252,000.

Contract for construction of class C loft-building for M. Levin has been awarded to William Martin, 110 Jessie street, San Francisco. Estimated cost is $30,000.

Schultz Construction Co., 739 34th avenue, San Francisco, was low bidder at $11,693 and was awarded the contract for construction of frame addition to gymnasium-building at Yerba Buena island. Other bidders were H. A. Klyce, $14,485; Hayes-Oser Co., $16,000; Grace & Bernieri, $16,-500; Monson Bros., $16,837.

Contract for construction of class A garage for J. C. Zellerbach has been awarded to Clinton Construction Co., 140 Townsend street, San Francisco, for $29,000.

Contract for making alterations in garage for Henry Cowell Lime & Cement Co. has been awarded to Caldwell & Son, 1913 Van Ness avenue, San Francisco, for $17,236.

Contract for construction of alterations and additions to reinforced concrete building for Mary's Help Hospital has been awarded to William M. Reedy for $28,444.

San Mateo, Cal.—Contract for construction of two-story reinforced concrete shop-building at high school has been awarded to Barrett & Hilp, Sharon Bdg., San Francisco, for $12,275.

Seattle, Wash.—Contract for construction of garage for W. G. Potts has been awarded to Great Northern Construction Co. for $20,000.

Contract for construction of brick and terra cotta apartment-house for E. E. Uden has been awarded to Warrack Construction Co., Arcade Bdg., Seattle, for $56,000.

Stockton, Cal.—Contract for construction of mill-construction warehouse for Sears-Roebuck Co. has been awarded to H. H. Larsen, 62 Post street, San Francisco, for $50,500. Contract for heating, plumbing, and electric work has been awarded to Otto Kurtz, 445 Stevenson street, San Francisco, for $7500.

Samson-Sieve-Grip Tractor Co. will construct two brick factory-buildings. Estimated cost is $70,000.

California Cedar Products Co. will construct factory for making pencils. Estimated cost is $30,000.

Tacoma, Wash.—Contract for construction of brick addition to plant of Pacific Brewing & Malting Co. has been awarded to Cornell Bros. for $100,000.

Washington, D. C.—C. L. Wold, 75 Sutter street, San Francisco, was low bidder at $36,254 for construction of concrete and hollow-tile building for the Bureau of Yards and Docks at Pearl Harbor, Hawaii. Hamilton & Chambers bid $54,190 and King Lumber Co., $89,000.

All bids for construction of post-office at Bakersfield, Cal., have been rejected, and work has been postponed indefinitely.

BONDS

Coalinga, Cal.—Election has been called for April 8 to vote on bond issue of $20,000 for completion of municipal water system, including the purchase of an auxiliary pump and additional fire-hydrants.

El Centro, Cal.—Election will be held April 8 to vote on bond issue of $15,000 for purchase of fire-fighting equipment.

Globe, Ariz.—Bond issue of $240,000 for construction of sewer system has been voted.

Bond issue of $200,000 for extension of water system has been defeated.

Monrovia, Cal.—Election will be held April 23 to vote on bond issue of $42,500 for extension of municipal water system.

Portland, Ore.—State Highway Commission has sold $500,000 worth of State Highway bonds to Henry Teal, Portland, at 91.17. This is on a 4.80 basis, since the bonds bear 4% interest and run for 25 years.

Sacramento, Cal.—State Board of Control has purchased $1,000,000 worth of State Harbor bonds.

No bids were received for the State highway bonds recently offered for sale, and the sale has been postponed again.

San Francisco, Cal.—Sierra & San Francisco Power Co. has applied to State Railroad Commission for permission to issue $1,000,000 worth of bonds. Money is to be used for additions and betterments.

San Pedro, Cal.—Bond issue of $160,000 for construction of four miles of concrete highway between San Pedro and Wilmington has been voted.

Santa Ana, Cal.—Election will be held April 15 to vote on bond issue of $46,200, $38,500 for construction of the Main Street bridge and $7700 for construction of the Flower Street bridge. Pacific Eectric Railway Co. will

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contribute $7000 additional to the cost of the Main Street bridge.

Tracy, Cal.—Election has been called for April 8 to vote on bond issue of $15,000, $10,000 for extension of sewer system and $5000 for extension of water system.

Vallejo, Cal.—Election will be held to vote on bond issue of $125,000 for purchase of Chabot Water Co. system.

Watsonville, Cal.—Bond issue of $190,000 for purchase of plant of Watsonville Water Co. failed to receive the necessary two-thirds majority.

MACHINERY AND SUPPLIES

Brisbane, Australia.—Bids will be received until May 31 by G. L. Beal, Under Secretary, Treasury, Brisbane, for furnishing and erecting steam-driven turbine electric generators and boiler-house equipment for the Inkerman irrigation area, near Townsville, North Queensland. Plans from Under Secretary upon deposit of $5.25 for each set.

El Centro, Cal.—Bids will be received until April 9 by F. H. McIver, secretary Imperial irrigation district, for furnishing an 18-in. electric-driven hydraulic dredge.

Bids will also be received until the same time for furnishing 20 all-steel 16-yd. side-dumping cars.

Fresno, Cal.—Contract for furnishing 60,000 to 100,000 bbl. of road-oil to county has been awarded to A. F. Gilmore Oil Co., Los Angeles, at $1.37½ per bbl., f.o.b. Taft. Union Oil Co. bid $1.45 f.o.b. Taft, Coalinga, or Bakersfield, and Standard Oil Co. bid $1.85 at the same points.

Great Falls, Mont.—Contract for furnishing 8379 ft. of 6-in. cast-iron water-pipe has been awarded to Central Foundry Co., Kansas City, at $65.47 per ton.

Los Angeles, Cal.—Contract for furnishing an eight-ton tandem motor road-roller has been awarded to Buffalo-Springfield Roller Co. for $2975.

Modesto, Cal.—Contract for furnishing 3000 ft. of cast-iron water-pipe to city has been awarded to American Cast Iron Pipe Company.

Oroville, Cal.—Bids will be received until April 5 by G. W. Ross, secretary board of high-school trustees, Jones Bdg., for furnishing one 30-in. band-saw equipped with 2-hp. motor, one No. 20 saw-bench, equipped with 5-hp. motor, one 8-in. planer and pointer, equipped with 2-hp. motor, and one 12 by 72-in. lathe and motor.

San Francisco, Cal.—Date of opening bids for furnishing railway-signal material for Twin Peaks Tunnel line has been postponed by Board of Public Works from March 27 to April 10.

Sunnyside, Wash.—Contract for furnishing wood-stave pipe for the Yakima-Sunnyside reclamation project has been awarded to Pacific Coast Pipe Co., Seattle, for $30,129.

Whittier, Cal.—City council has purchased 1000 water-meters from the Neptune Meter Co. When these have been placed, the entire municipal system will have been metered.

Yuba City, Cal.—Contract for furnishing five oil-burning tractors to county has been awarded to Dauch Manufacturing Co., Sandusky, Ohio, for $11,250.

POSITION WANTED

CONSTRUCTION SUPERINTENDENT on hydro-electric irrigation projects. All classes reinforced concrete structures a specialty. Address Box 25, Western Engineering.

MISCELLANEOUS

Los Angeles, Cal.—Contract for construction of Second Street tunnel has been awarded to John Hayes, 117 West 30th street, Los Angeles, for $956,882.73, $911,010 of which is for the tunnel proper and the remainder for the street work on the approaches. Some of the individual items are as follows: 99,700 cu. yd. excavation, $124,625. Hauling excavated material, $54,835. Timbering, $52,588. Concrete work, $153,027. Brick work, $67,755. White-enamel tiling, $57,785. Steel reinforcement, $25,330. Los Angeles Planing Mills Co. bid $993,000.

Oakland, Cal.—City council has leased 68 acres of land on western waterfront to Parr-McCormick Steamship Company.

San Francisco, Cal.—Base Metals Mining Co., Puente, has applied to State Water Commission for permission to divert water in Inyo county for mining. Plans include pipe-line 1.2 miles long. Estimated cost is $3500.

Contract for grading lot at Folsom and Hawthorne streets for Wells, Fargo & Co. has been awarded to J. P. Holland, San Francisco, at $0.80 per cu. yd., or $22,000 in all.

Tacoma, Wash.—Contract for construction of hydraulic fill one-fourth mile long extending from the Hylebos waterway to the East Side drive and requiring 45,387 cu. yd. embankment has been awarded to Tacoma Dredging Co. for $27,445.

Vallejo, Cal.—Following bids were received at Mare Island Navy Yard for moving tanks at the Puget Sound Navy Yard: Charles C. Moore & Co., $13,600; Western Erecting Co., $15,750 or $18,250 according to conditions; A. H. Vogt, $17,465. All San Francisco firms. Bids were also received at the Puget Sound Navy Yard and at Washington, D. C., but information regarding these bids has not yet been received.

Bids for construction of reinforced concrete slab-floor have been rejected and work will be postponed indefinitely.

PROPOSALS

NOTICE TO CONTRACTORS

Notice is hereby given that the Council of the City of Alameda will receive bids for the construction of a single track railroad along Clement Avenue beginning at the intersection of Clement Avenue with the westerly property line of the Southern Pacific Railroad and extending westerly along said Avenue to the westerly boundary line of Grand Street, in accordance with plans and specifications therefor, now on file in the office of the City Engineer at the City Hall.

Bids are asked for in three alternative propositions, as follows:

1. For furnishing all materials, labor and equipment for the construction of said railroad; or
2. For furnishing all labor and equipment for the construction of said railroad, the city to furnish all material; or
3. For the furnishing of all material.

Each proposition above designated shall be itemized as per the specifications herein above referred to. The Council will, in its discretion, award the contract to the lowest responsible bidder, and the right is reserved to reject each proposition or each item separately, or as a whole.

Each bid must be accompanied by a certified check for ten per cent of the amount of said bid, payable to the Mayor of the City of Alameda to guarantee that the successful bidder will enter into a contract at the prices and upon all other terms and conditions specified in his bid. If he fails to enter into such contract within six days after the award of same such certified check will be forfeited and become the property of the City of Alameda.

A deposit of $5.00 for each set of plans and specifications will be required, to be refunded upon the return of said plans and specifications.

All bids must be in writing, must be sealed and marked "Bid for the Laying of a Railroad Track on Clement Avenue" and must be filed in the office of the City Clerk of the City of Alameda at the City Hall, at or before 8 o'clock p.m. of Tuesday, April 9th, 1918, at which time said bids will be opened. By order of the Council of the City of Alameda.

C. E. HEWES, City Manager.

New and Used Contractors Machinery For Sale

1—½ yd. Ransome mixer.	30 to 2000 ft. air compressors.	130 tons tank steel.
1—¾ yd. Chicago mixer.	Air and water hose.	Gasoline engines, all sizes.
450 tons structural steel.	¾ yd. Smith mixer.	1900 tons 56 pound rail.
Triplex pumps, all sizes.	Concrete buggies and wheelbarrows.	250 tons 6″ pipe.
12—16—20 pound rail.		5—Ingersoll-Rand jackhamers.
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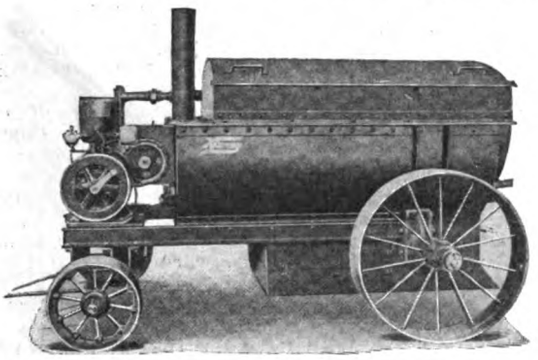

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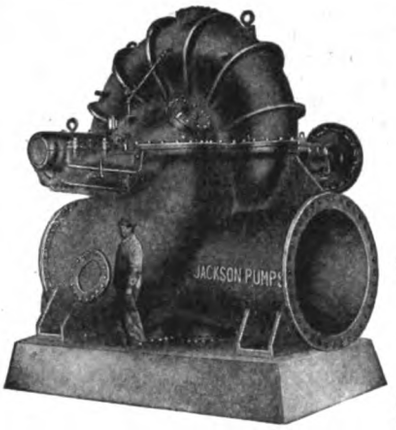

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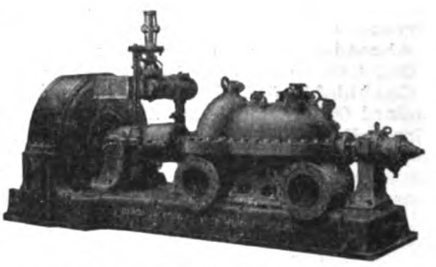

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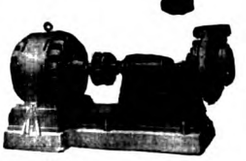

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